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AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

OCTOBER, 1836.

Practical and Theoretical Mechanics.

Report of the Committee of the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, on the Explosions of Steam Boilers. PART II.,* *containing the* GENERAL REPORT *of the Committee.*†

The Committee appointed "to examine into the causes of the explosions of the boilers used on board of steamboats, and to devise the most effectual means of preventing the accidents, or of diminishing the extent of their injurious effects," respectfully submit to the Board of Managers of the Franklin Institute, the following report:

The Committee undertook the task imposed upon them by the Franklin Institute, with a deep sense of the responsibility which it involved. On the one hand, a series of disasters by which human life was sacrificed, called loudly for an investigation of the causes which produced them; on the other, an untimely or ill-directed interference with a branch of industry, which has been a source of unparalleled advantage to our country, was truly to be deprecated.

Emanating from an Institute "for the promotion of the Mechanic

* For Part I. See Vol. XVII.

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Arts," the Committee felt advantageously situated. They could not justly be suspected of a desire to trammel the progress of any art; and yet the public confidence, which had always been accorded to the institution, would naturally attach to a Committee selected by it.

The Committee further believed that the apprehensions of the public, aroused by the frequent recurrence of accident, could only be satisfactorily allayed by an investigation, which would show that such accidents were not unavoidably incident to the useful agent which they distrusted, but resulted from a want of due regulation of its power, or from circumstances incidental to its use which could be foreseen, and therefore guarded against. If disappointed in this anticipated result of investigation, the Committee hoped to satisfy those who are public carriers, that it was their duty to provide protection for those who trust life in their hands, against an agent thus found to be uncontrollable.

With these views the Committee commenced, actively, the collection of information upon the subject intrusted to them. The replies to their circular were canvassed in their meetings, and finally laid before the public.* It occurred most opportunely for the ultimate success, though not for the rapid completion of their labours, that an opportunity was afforded them for experiment, by which to test many of the suggested causes of, and preventives to, the explosions of steam boilers.

These experiments, originally proposed by our public spirited fellow-citizen, S. D. Ingham, Esq., then Secretary of the Treasury of the United States, have been brought to completion and presented to the public under the auspices of the present Secretary.†

The Committee trust that they have, by the experiments just referred to, shown not only what are some of the causes of explosion, but, which is quite as important, what are certainly not causes. In this way they hope to have turned away the attention of ingenious men from false hypotheses which cannot furnish the remedies they are in quest of, and to have pointed out some directions in which their labours may be profitably bestowed.

A desire to complete the reports upon their experiments, has induced a delay in the present report, which, thus far, however, the Committee are satisfied will be found to have been judicious. This conclusion they rest upon the many references, which will appear in the following pages, to those experiments, which have given an authority to recommendations and suggestions, that could not have been claimed for them unless thus strongly supported by facts.

They regret much that the part of their report referring to the strength of materials will, from circumstances, be unavoidably incomplete. This deficiency, they hope, will hereafter be made up, the experiments on the subject having been some time since concluded; and they do not feel warranted, by this cause, in any longer delaying their general report.

* As these replies will be frequently referred to in what follows, it is proper to state here, that the references are made to the pamphlet distributed by the Committee to their correspondents and others, and that Nos. I. to XIII., both inclusive, were published in the "Journal of the Franklin Institute of Pennsylvania for the promotion of Mechanic Arts," Vol. VIII.; Nos. XIV. to XXVIII., both inclusive, in the same Journal, Vol. IX.; No. XXVIII., part second, and XXIX., in Vol. X.; and No. XXX. in Vol. XI.

† Hon. Levi Woodbury, for whose promptness in forwarding their views, the Committee beg leave here to return thanks.

In this report the Committee have endeavoured, by examining the different accounts of explosions on record, and the writings on collateral subjects, to ascertain what causes have been operative in producing these disasters. The difficulty of procuring satisfactory testimony in regard to them, has been often pointed out. Most frequently those from whose mismanagement or want of vigilance they have immediately resulted, have been victims to them, and when they have survived, the precise state of things before the occurrence was imperfectly known to them; and, however honest, their minds have received a bias towards the non-existence of certain circumstances judged likely to have produced the results.

It hence follows that in regard to many explosions, either none of the circumstances which immediately preceded them, and bearing upon them, are known, or by inaccurate statements of them, an appearance of mystery is thrown around the whole matter, calculated to baffle research, and to alarm the community, who are exposed to a recurrence of the same dangers. Thus it happens that of the numerous explosions on record, few are made to subserve the cause of humanity, by a knowledge of their proximate causes. The details of the number of killed and wounded, and of the more or less entire destruction of the boilers and of the boats, are given in the daily prints, and public curiosity is satisfied.

In making their examination, then, of the cases of explosion, the Committee have selected such as they have found most directly to the points in support of which they are cited; omitting others in which the facts are less clearly made out, or in which the causes assigned may be resolved into matters of opinion. Having themselves no theory, or theories, to support, they have of course not been biassed, by such views, in the selections made.

This mode of proceeding is, obviously, not calculated, by one effort, to exhaust a subject. But the Committee believe, that they are able to make a decided step forward in the knowledge at present existing, in a connected form, on this subject. That to the causes pointed out by a Committee of the British House of Commons,* in 1817, namely, improper construction or material of a boiler and undue but gradual increase of pressure, they will be able to add others as important, and as fully proved as the former. Nor will any cause for alarm result from this extension, since it will be found that it is only ignorance of these circumstances which constitutes their danger, and that they may be prevented from occurring and remedied when they occur. It will be full time after the well-ascertained causes of explosion have been duly guarded against, to look for others more occult in their nature, if indeed there are such.

In the following report, the Committee propose to examine separately the circumstances which they consider as the proximate causes of explosions in steam boilers, and the preventives or remedies which have been proposed to meet them. Under each division of the subject they will make the suggestions or recommendations to constructors and others, which they base upon the previous discussion; and at the close of the Report, will present a project of a law for carrying into effect, in regard to steamboat boilers, those recommendations which are of primary importance.

It will be observed thus, that while they do their duty to the arts by pointing out as far as their knowledge extends what they consider improve-

* Charles Harvey, Esq., Chairman.

ments or valuable alterations, they do not propose to render imperative any measures but such as are required for public safety.*

In submitting this project the Committee obviously do not entertain a doubt of the competency of Congress to legislate on the matters embraced in it. The several discussions in that body on the subject,† the recommendation of the President of the United States,‡ and especially the very detailed provisions of the bill recently proposed in the Senate, fully sustain them in this opinion. They consider the question now to be, not whether any regulations may be made, but how those to be made may be rendered most efficient and complete. For this completeness the very respectable Committee§ who reported the bill referred to, in the Senate of the United States, have expressed themselves anxious; and the labours of this Committee, so far from being an interference, will, no doubt, as far as they may be approved, be looked upon as forwarding the views thus expressed.

The good effects which have attended the adoption of partial preventives in England, and the excellent effects from the more complete ones in France, should urge us, as Americans, to do our part in preventing further destruction of life and property by these disastrous explosions. And while we apply means for this purpose, experience and reason both teach us that they will produce no undue or severe restraints upon mechanical skill or commercial enterprise, but rather that they will aid both, by increased confidence on the part of the public.‖

The Committee propose to investigate the different causes of the explosions in steam-boilers under the following general divisions.

I. Explosions from undue pressure within a boiler, the pressure being gradually increased.

II. Explosions produced by the presence of unduly heated metal within a steam-boiler.

III. Explosions arising from defects in the construction of a boiler or its appendages.

IV. Explosions resulting from the carelessness or ignorance of those intrusted with the management of the steam-engine.

V. An examination of the particular cases of collapse of a boiler, or its flues, by rarefaction within.

I. Explosion from undue pressure within a boiler, the pressure being more or less gradually increased.

1. This is one of the most natural causes to look to as producing the bursting of steam-boilers, and one which, probably, is as frequently operative as any other. It might be supposed that with a safety valve always applied and a mercury gauge so easily applicable, the low pressure boiler should have been exempted from explosion. But such has never been the

* This project is put forth with a view to free discussion, without which the Committee would feel entirely unwilling that it should be adopted. They propose, with this view, to distribute it as widely as possible, and invite especially a discussion of its provisions, in the Journal of the Franklin Institute.

† See Act regulating steam vessels, proposed in 1824, mainly founded on the action of the Committee of Councils of Philadelphia; and especially the report of Mr. Wickliffe, from a Select Committee of the House of Representatives, May 1832. [Pub. Doc. Rep No. 478.]

‡ In the annual message for 1833.

§ The Committee on Naval Affairs. Hon. Samuel L. Southard, Chairman.

‖ Professor Silliman, in an article on the safety of steamboats, has the following strong expression of opinion: "The boat which is first ascertained to afford absolute security will be a fortune to its proprietors."—Silliman's Journal, vol. XIX. p. 146.

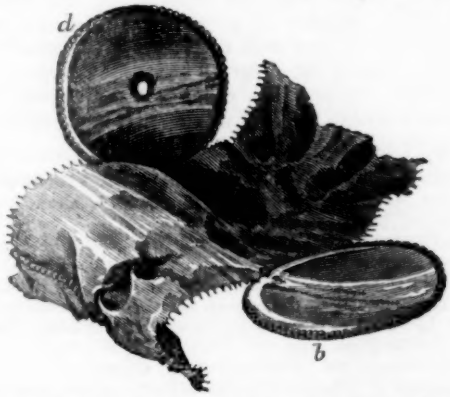
case, and we find a select Committee of the British House of Commons, in 1817, specially directing their inquiries to the cause above stated, as producing the disastrous explosions which, even at that day, called for legislative interference.

2. That a gradual increase of pressure can produce all the effects of the most violent explosions, may be inferred from many cases on record, attributed with probability to this cause; and was proved conclusively by the direct experiments of this Committee. In these latter, cylinders of copper and iron were violently torn asunder, the parts thrown from their places, scattering the materials of the temporary furnaces over which they had been heated, and of the fire, to considerable distances.* There are also cases well made out in which a weak place in a boiler has acted as a safety valve, but such fortunate circumstances are not always to be looked for, and better methods have been devised of effecting the same object, than to imitate them by the use of thin plates. The idea stated to be current,† namely, that a boiler does not explode if duly supplied with water, is wholly untenable and highly mischievous in its tendency.

* This effect is well illustrated by the rendering of a copper cylinder just referred to. The subjoined figure and extract are from the first part of the report of the Committee on Explosions, &c. p. 68. (Jour. Franklin Institute, vol. xvii. pp. 224, 225.)

"As before, nothing remarkable occurred previous to the instant of explosion, and the members of the committee, employed in the experiments, were engaged in observing the boiler at the instant it exploded. A dense cloud of smoke and flame, capped by steam, rose from the pit; the stones and combustibles were widely scattered, and the boiler was thrown, in a single mass, about fifteen feet from the furnace. The noise attending this explosion was like that from the firing of an eight inch mortar.

"The boiler was rent as shown in the accompanying figure, giving way in an irregular line, just above the probable water line on one side of the boiler, but not conforming to it. *d* and *b* were the lowest points in the two heads before the explosion. The



sheet of copper was torn from the heads, unrolled and irregularly bent, adhering to the heads for only a short distance near the top of each; and the heads were bent outwards. The thickness of the copper along the line of rupture varies from 0.25 to 0.35 of an inch, and the metal appears to have been highly heated at one end of the torn portion."

† Replies to Circular of Com. on Explosions, &c. No. XII. Report of Thos. Bakewell, Esq.—"at a subsequent period and after the captain had conversed with some of those who contend that a boiler cannot burst with 'fair play,' as it is termed."—To meet this prejudice, the Committee have chiefly selected their proofs from accidents which have occurred abroad.

3. We are warranted, then, in looking to the failure of the apparatus designed to prevent undue pressure, or to the misuse of it, as the cause of explosions of the most violent kind. The current of testimony is too strong to permit the former view to the exclusion of the latter. It has been too clearly shown that those who have charge of the steam engine sometimes not only neglect the means of safety provided, but actually render them inoperative. Not to multiply instances, the Committee refer to the following as entirely well made out, and in which the connexion between the misuse of the means of safety and the explosion is fairly to be inferred. First; That of a cast-iron boiler used in a sugar-house in Well-close-square,* London, the mercury gauge attached to which was plugged up and the safety-valve purposely overloaded at the time of explosion. Second; The case of a steam tow-boat on the Rhone,† in France, when the safety-valves of the four boilers were fastened down, so as to be immoveable. Third; The explosion of one of Trevithick's locomotives,‡ when the safety-valve was kept down to raise steam at starting. Fourth; The explosion in the steam carriage of Messrs. Burstall and Hill,§ when in going over a soft piece of road, in which the coach laboured, the engineer kept down the safety-valve, by pressing upon the lever. And Fifth; The explosion of the boiler of the steamboat New England from a "pressure of steam, produced in the ordinary way, but accumulated to a degree of tension which the boilers were unable to sustain."‖

4. If the apparatus devised for the low pressure boiler has been rendered inoperative, the high-pressure boiler has had to contend with peculiar difficulties. No gauge applicable to it has yet been brought into use. The open gauge must be of undue height, or cumbrous in its serpentine form; and the closed gauge requires great nicety in construction, and a correction for the temperature of the air enclosed in it. A graduated safty-valve would give the engineer desirable information, and has been to a certain extent used. The engineer of a locomotive engine, where the spring weighing machines are used with the safety-valves, has it in his power to ascertain at any moment, the pressure within the boiler.

He has it is true besides, the power of keeping the valve down even when the pressure within may be unsafe, but then he and his assistants would probably be the only victims of its abuse.

* Minutes of evidence before a Select Committee of the House of Commons, &c. &c. by Geo. Dodd, Civ. Eng. Evidence of Mr. Braithwaite, Mr. Richter, &c. Also, Partington on the Steam Engine.

† Annuaire du Bureau des Long., 1830, p. 141. Jour. Frank. Inst. vol. v. p. 401. It is stated in the London Jour. of Arts, that the pistons of the engine had become fixed in the cylinders by being expanded more rapidly than these latter, and that Mr. Steele, the manufacturer of the engine, supposed the steam to be insufficient, and was induced by the desire to have his engine succeed, to adopt a device which resulted so fatally. London Jour. Arts, vol. xiii. p. 346.

‡ Minutes of Evidence, &c. Evidence of Mr. Chapman.

§ Reply to Circular of Com. on Explosions by L. Hebert, Esq. of London, No. II. See also the bursting of one of Hancock's boilers, from the fastening down of a safety-valve. Lond. Mech. Mag. vol. xviii., and Jour. Frank. Inst. vol. xi. p. 227.

‖ The part marked with inverted commas is the conclusion drawn by an able committee who investigated the cause of this explosion. It is unpleasant to see in this case, how those concerned in the press of steam, were biassed in their views given to the committee and communicated, as the committee testify, as honest convictions, and without intention to deceive. The engine men were not injured by the explosion. The form of these boilers was no doubt defective, and one part of them will be commented on hereafter. The two boilers exploded almost simultaneously.—Jour. Frank. Inst., vol. xiii. pp. 55 and 126.

5. The extraordinary and fatal increase of pressure which the Committee have above shown to be produced designedly at times, has at others been attributed to the adhesion of the safety-valve. A practical engineer, Mr. John B. Calhoun, has given a remarkable instance of this kind* as occurring to a safety-valve on the boiler of the steamboat Legislator, then navigating the Hudson. The mercury-guage indicating an undue pressure within the boiler without the raising of the valve, the engineer endeavoured first to raise it by a cord which passed into the fire-room: failing in this he went to the top of the boiler where the valve was, and moved the weight upon it towards the fulcrum, but without effect. He then applied his force at the end of the lever to raise it, when suddenly the valve opened with a loud report, and the flow of steam commencing lasted some time before the elasticity had diminished to its usual degree.

6. In this case, there can be but little doubt that the valve had corroded upon its seat or was fastened by the drying of oil, or other matter, to it. The carelessness of the fire-man who had charge of the boiler, and whose duty it was probably to raise the valve from time to time, is fully proved by his allowing the steam to get so high, that the rod of the mercury-gauge was against the boiler-deck, without giving notice to the engineer. Had not the latter observed, from the rapid working of the engine, that the steam was high, and investigated the matter, the lives of many would, no doubt, have been sacrificed.

7. The experiments made by M. Clement Desormes† on the tendency of disks, when placed in front of an aperture, through which air is forcibly issuing, to approach it, led him to condemn the safety-valve entirely, and especially the disk form. This sentence does not seem to the Committee to be just,‡ since the tendency upward, under the most favourable circumstances to its action, is very limited in amount, and may easily be counteracted by a device, which will lessen the acting weight, when a safety-valve is raised. Besides, the proportion which the area of the disk bears to that of the aperture materially affects the amount of this tendency, and is, in practice, very much less than was used in the experiments of M. Clement. The ingenious experiments of M. Hachette and Messrs. Hopkins and Roberts of Manchester, have shown the truth of these remarks.§ If

* Account of an extraordinary adhesion of the safety-valve of the boiler on board the steamboat Legislator, on the Hudson. By the Engineer. Jour. Frank. Inst., vol. v. p. 355.

† Notice in Franklin Journal vol. iv. p. 97. See also explanations of the phenomenon offered by Jacob Perkins, Esq. in the same volume, p. 252, and in London Jour. Arts, vol. xiii. p. 275. By Doct. Hare in Jour. Frank. Inst. vol. ii. p. 58. By James P. Espy, Esq. in the same vol. p. 59, and by Asa Spencer, Esq. in the same vol. p. 61. also remarks on p. 203.

‡ In this view the Committee coincide entirely with M. Arago. See Annuaire du Bureau des Long. 1830, p. 137, and Jour. Frank. Inst. vol. v. p. 408. In fact the committee named in the next note did not sustain the deduction, above referred to in the text, remarking, in very guarded terms, that the limits within which the phenomenon occurs were then not sufficiently known, to decide upon the possibility of an accident from it.

§ M. Hachette who investigated this subject shows in a strong point of view the effect of the relative proportions of the disks. When one is not many times the other in size it is impossible to satisfy the conditions of the problem. Annales de Chim. et de Phys. vol. xxxv. p. 44, &c. The Committee who examined this subject in its relation to the Steam Engine, consisting of MM. Biot, Poisson and Navier, made an experiment in which with a disk, nearly six times the diameter of the opening, and a pressure of steam about 2.8 atmospheres, the tendency to adhesion when the disk was .01 of an inch from the opening, was but half a pound. Annales de Chim. et de Phys. vol.

however, this action were allowed to have full effect, by dimensions in the valve expressly intended to produce it, an increased area of valve would entirely obviate the objection. Different effective means of lessening the acting weight, on the rise of a safety-valve have been used or proposed, such as that employed by MM. Arago and Dulong* in their experiments, on the elastic force of steam at different temperatures, or the very similar one, described by Mr. L. Hebert in his interesting communication to this Committee.† In them the weight rolls towards the fulcrum when the valve opens.‡ The Committee apprehend that this form, although very effective while in order, would tend by disuse to lose its power of action. They would prefer, in practice, a construction similar to the second form proposed by Mr. Hebert in which the lever being curved effects the same object, while the weight is not required to be moveable. They intend to recommend a suitable form of lever of this kind.

The practice of passing the stem of a safety-valve through a stuffing box, as it is calculated entirely to defeat the object of the valve, should never be allowed. In fact the more open to inspection all the parts of the apparatus are the better. If it is necessary to carry off the steam from that which the engine-man has the control of, it can be accomplised without resort to packing.

9. There can be no doubt that the form of the safety-valve materially influences the certainty of its action. Although the disk-valve was early recommended, the nicety of workmanship required to make it tight has limited its use, and perhaps the experiments of M. Clement have produced a prejudice against it. The cone, which is in common use, may be more easily tightened when perfectly fitting the seat; but this very fact is an objection to it. No pressure can cause the disk valve to prevent the escape of steam, if the valve and seat be clean, unless they have been ground to fit. The Committee adopted this form of valve in their experiments,§ and in no instance was undue adhesion observed. Throughout their experiments, the pressure of the steam corresponding to the opening of the valve with its different weights, was noted by the steam-gauge, or by the temperature of the water within the boiler. No means were used to keep the valve in other than what might be considered fair working order, but when, from the action of dirt, it had become leaky, the grinding upon the seat was very easily performed, and restored its efficiency. Two valves of the same form were used, and the comparison of the calculated pressures due to the weight upon the valve, with the observed pressures at which the valve rose entirely, or leaked so badly as to require additional weight, uniformly gave the former in excess. The average ratio in the experiments was 1 to 1.035, the former number representing the observed, and the latter the calculated, pressure.

xxxvi. p. 70. In the experiments of Messrs. Hopkins and Roberts, with an excess of pressure in the effluent air of .05 of an atmosphere, over atmospheric pressure; the total tendency to adhesion at its maximum, was but .005 of an atmosphere, with an opening of 2$\frac{8}{8}$ inches, and a disk of six inches in diameter. With a disk of eight inches in diameter the total tendency was increased from 32 oz. avoirdupois, to 48 oz: and with disks 4$\frac{4}{8}$ in. diameter and under, no such tendency was manifested, the aperture of efflux remaining the same. Manchester Trans. vol. v. N. S. and Jour. Frank. Inst. vol. x. p. 188.

* Annales de Chimie et de Phys. vol, xliii.

† See replies to circular of Com. on Explosions, No. XI.

‡ In that of MM. Arago and Dulong there was also an arm projecting on the opposite side of the fulcrum from that on which the weight keeping down the valve was placed; upon this a weight rolled from the fulcrum on opening the valve.

§ Report of Com. on Explosions, part I. pp. 71,&c. Jour. Frank. Inst. vol. xvii. p. 228.

10. These conclusions are sustained, in a general way, by the success which has attended the recommendations of the select committee of the British House of Commons. The law, based upon their investigations, requires that there should be two safety-valves upon every boiler, one of which is out of the control of the engineer,—and further provides a penalty for the overloading of either valve, by any person whatever.*

11. In addition to two safety-valves, the regulations for the safety of the steam engine in France, require two fusible plates or plugs, of suitable diameter, to be attached to every boiler. These plugs are intended to act by the heat of the inclosed steam, and to give way when it has reached a certain point. In the application of them which we are now considering, they are exposed to a pressure corresponding to the temperature, and in order to prevent them from giving way as they verge towards the fusing point, they are covered with wire, or with perforated disks or gratings of metal.

12. This mean of safety was made the subject of elaborate experiments by this Committee.† The result was, that when alloys of tin, lead, and bismuth, such as are used for fusible plates, are exposed to heat and pressure, parts of them soften at temperatures below that at which the entire plate would become liquid. Being exposed to pressure, these fluid parts are forced out.‡ leaving a less fusible mass. In one case described by the committee, this operation was carried so far before the plate gave way, that from a plate melting at 254° to 275° Fahr., was produced a mass fusible only at 312° to 345°. One part of the alloy which oozed out was found to melt at 223° and another at 233°.§ To this action a fusible plug

* The regulations relating to the safety-valves of steamboat boilers, are as follows:

That every such boiler shall be provided with two sufficient safety-valves, one of which should be inaccessible to the engine-man, and the other accessible to him and to the persons on board the packet.

That the inspector shall examine such safety-valves, and shall certify what is the pressure at which such safety-valves shall open, which pressure shall not exceed one-third of that by which the boiler has been proved, nor one-sixth of that which by calculation it shall be reckoned to sustain.

That a penalty shall be inflicted on any person placing additional weight on either of the safety-valves.

Of twenty-three witnesses, practical engineers and others, examined by the Parliamentary Committee, seventeen recommended explicitly the additional safety-valve, out of the control of the engine-man.

† Report of the Com. on Explosions, of the Franklin Institute, Part I. p. 23. "V. Inquiry in relation to plates of fusible alloys." Jour. Frank. Inst. vol. xvii. p. 74.

‡ This fact, but to a limited extent, seems to have been noticed by M. Gualtier de Claubry, who did not, however, follow out the suggestion. Receuil Industriel, 1829.

§ The entire series of conclusions from these experiments, which formed one of the most interesting branches of the Committee's investigations, are as follows:

"The conclusions deduced from the foregoing experiments, on metallic alloys, may be thus stated.

"1st. The impurities of common lead, tin, and bismuth, are usually not such as to affect materially the fusing points of their alloys.

"2d. When mixed in equivalent proportions, tin and lead formed alloys, not presenting the characters of distinct chemical compounds, in definite proportions. The alloys between the range of one equivalent of tin, to one of lead, and one equivalent of tin to six of lead, varied considerable in the interval between the temperature of commencing to lose fluidity, and that at which a thermometer, immersed in the solidifying metal became stationary. These different alloys produced nearly the same stationary temperature in a thermometer plunged into the solidifying metal.

"3d. Fusible metal plates covered by a perforated metallic disk, and placed upon a steam-boiler, show signs of a fluidity at the disk, before the steam has attained the

would be also exposed, and the committee are of opinion that no method of application in which the pressure acts upon these compounds, can be efficient in practice.

In the experiments referred to, the plates being thin, were generally burst by pressure; not, however, acting precisely as thin plates of copper or iron would have done, but being partially softened by heat.

13. While the Committee deem it very desirable that a convenient steam gauge applicable to high pressure boilers should be devised,* they consider that until this is done, a substitute should be furnished in a graduated safety-valve, marked with numbers expressing directly in pounds to the square inch the bursting† pressure of the steam, and within the control of the engine-man. This would act as a convenient, and, for practice, a sufficiently exact method of knowing what he ought always to be informed of, the bursting pressure in the ordinary working of the boiler. Besides this, however, there should be a lock-up valve, for the original weighting of which there should be a proper responsible agent, and which should be capable of being raised by the engine-man, but not of being kept down. With a valve of this kind of sufficient dimensions, of proper form, and duly weighed, the Committee believe that danger from gradually increasing pressure might be entirely avoided.

A thermometer suitably graduated and passing into the steam or water of the boiler, would prove under ordinary circumstances, a useful gauge, and may be conveniently applied as described in a subsequent part of this report.

14. With a view to meet the dangers which have been discussed in this section, the Committee would make the following recommendations, the means of carrying out the principal of which, by law, will be found suggested at the close of the report:—

temperature of fusion of the alloy of which the plate is composed. This fluid metal oozes through the perforations in the disk, and the plate thus looses much of its substance before finally giving vent to the steam.

"4th. The under parts of the plate are not kept from fusion by a protecting film of oxide there formed.

"5th. The thickness of the plate is not important, provided only that it is sufficiently strong to resist the pressure of the steam at temperatures below its point of fusion.

"6th. The temperature at which the plates are cast, and the rate of cooling of the cast metal, do not affect the temperature at which the plates give vent to steam.

"7th. The effect stated in conclusion third, is explained by the nature of the alloys used, which are formed of portions of different fluidities; the more fluid parts, are forced out by the pressure of the steam, leaving the less fusible. These latter, in general, are burst, not melted.

"8th. By pressure in a receptacle provided with small openings, this effect of separating the differently fluid portions of an alloy, may be imitated.

"9th. Fusible alloys, used to indicate the temperature of any part of a steam-boiler, should not be exposed to the pressure of the steam; at least not in such a way that the separation of the differently fusible constituents of the alloys may be effected."—Report of Com. on Expl. Part I. p. 34, and Jour. of Frank. Inst. vol. xvii. p. 84.

* The Committee regret that the hydrostatic safety-valve of Mr. Ewbank has not been brought into use. It would answer, by a slight modification, as a gauge, and no doubt can exist of its being applicable to the stationary engine. The oscillation of the liquid may interfere with its operation on board of steamboats, but to what extent the Committee are not prepared to say. See description and figures Jour. Frank. Inst., vol. ix. p. 64, and, vol. x, p. 2.

† This term is used to signify the excess of pressure of the steam within, over atmospheric pressure, in contradistinction to the *working* pressure, which is used to express the total elastic force of the steam.

First. That every boiler be provided with two safety-valves, each of which shall be competent to discharge the steam, made in the ordinary working of the engine. The first of these valves should be graduated by the maker of the engine, and have stamped upon the lever by which it is weighed, the bursting pressure at which it will open, by calculation, when the moveable weight is placed at the several notches. The pressure corresponding to the last notch to be equal to the bursting pressure, under which the engine is to work. The second valve to have a weight fixed immoveably upon it, the pressure of which upon the seat, together with that of the atmosphere upon the valve, is equal to the working pressure of the engine. This valve should be so arranged as to admit of raising, but not of placing additional weight upon it. To this end it should be inclosed. The rise allowed by the inclosure should rather exceed half the radius of the valve seat.

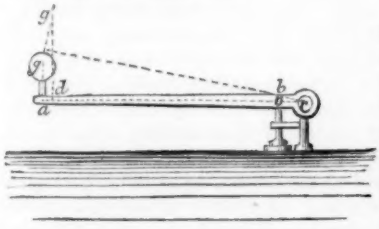
Second. The Committee recommend to constructors the disk valve. The diameter of the disk should not exceed once and a half that of the valve seat, as a less ratio than this will leave sufficient margin, and any sensible tendency to close from the effect of the issuing current will certainly be avoided.

Third. That a cord be attached to the lock-up valve, by which it may be raised at the same time with the free valve. And that the working of each be ascertained at least every two hours.

Fourth. That an open mercury-gauge be provided for each boiler of every engine not carrying more than two atmospheres of working pressure. The height of the mercury to be indicated by a float which shall truly mark upon a graduated scale the bursting pressure in inches.

For high-pressure boilers they recommend the thermometer, graduated to show the pressures corresponding to the temperatures of saturated steam, as a convenient gauge.

Fifth. That the lever of the lock-up valve be bent upwards at the end, so that in rising it shall relieve the valve of part of the weight. A suitable proportion for such relief would be about one-tenth of the pressure derived from the weight, and the height of the bend above the lever should be regulated to meet this.



The lever would have a form similar to the annexed. The part *a g*, which is turned up, may be straight or otherwise. The adjustment should be made so that *d c* is nearly nine-tenths of *a c*. *g* being the centre of gravity of the ball, lever, &c. will lie a little out of the centre of the weight, towards the fulcrum.

Sixth. As there can be no doubt that the competition in regard to speed is, or has been, a strong temptation to an undue increase of pressure by engineers or firemen, it should be expressly prohibited by law.

II. *Explosions produced by the presence of unduly heated metal within a steam-boiler.*

15. In a properly constructed steam-boiler no part of the metal is exposed to the direct action of the fire without being immediately in contact with water: the temperature of the metal cannot be raised above that of the water, and is thus determined by the weight upon the safety-valve.

When, from any cause, the metal is not so circumstanced, it becomes unduly heated, and danger may arise from two sources; first, the metal is weakened and rendered less capable of resisting even ordinary pressure; second, it serves as a reservoir of heat ready to bring into existence highly elastic steam, whenever water shall obtain access to it.

16. The first of these positions rests upon the basis of direct experiment, and is, the Committee believe, generally admitted.* Their experiments on the strength of materials have, however, developed a curious fact in regard to the strength of malleable iron, namely, that it slowly increases at first with an increase of temperature, and attains its maximum at a temperature above that at which any of the steam-engines used in practice, are worked. Above this maximum, the decrease of strength is very rapid; so as to be, at a red heat, but about one-sixth of that at ordinary temperatures. Copper, on the contrary, is weakened by any increase of temperature above the lowest, which was tried, namely, 32° Fah. The fact just stated in regard to iron, is interesting in its application to the proof of iron boilers, by the water-press, and as showing the great, and rapidly increasing, danger from diminished strength, as the metal is raised above the temperature of maximum strength.

17. Secondly the heated metal serves as a reservoir of heat to furnish highly elastic steam, when water is in any way brought into contact with it. That highly heated metal can produce steam, rapidly, has hitherto been a controverted position. In the experiments of Klaproth, successive drops of water thrown into an iron spoon, originally heated to redness, vaporized the more rapidly as the metal lost heat. In the experiments of Perkins and others, larger quantities of water in highly heated metallic vessels, vaporized very slowly. It is true that by injecting water into an iron cylinder, heated to redness, Mr. Perkins found a sudden increase of elasticity; but he attributed the effect to the hot and unsaturated steam which the cylinder contained, and through which the ejected water passed.† The Committee found that the temperature of clean iron at which it vaporized drops of water most rapidly, was 334° Fah.‡ The developement of a repulsive force is so rapid above this temperature that drops which required but one second to disappear, at the temperature of maximum vaporization, required 152 seconds when the metal was heated to 395°. One-eighth of an ounce of water introduced into an iron bowl, three-sixteenths of an inch thick, and supplied with heat by an oil bath, at the temperature of 546° Fah., was vaporized in fifteen seconds, while at the initial temperature of 507° Fah., that of most rapid vaporization under these circumstances, it disappeared in thirteen seconds. The cooling effect of the water upon the metal is here strikingly shown, by the increased temperature to which the latter has to be raised at the beginning of the experiment, in order to give the most rapid vaporization. A further illustration of the same kind is afforded by comparing the temperature giving most rapid vaporization, when the metal of the bowl is supplied with heat by a good and a bad conductor, or imperfect circulator, as by a bath of tin and one of

* In the minutes of the Select Committee of the House of Commons there is a statement by Mr. John Steel that cast-iron is strongest at the temperature of 300°, but it is not supported by reference to experiment.

† Franklin Journal, vol. iii. p. 418. Lond. Mechs. Mag. or Jour. Frank. Inst. vol. ix. p. 348.

‡ Report of Com. on Explosions. Part. I. Vaporization of drops." Reply to Query VI. Jour. Frank. Inst. vol. xvii. p. 90.

oil. With a rough surface, an iron bowl one-quarter of an inch thick, vaporized one-eighth of an ounce of water most rapidly by introducing it when the metal was at 555° Fah., the bowl being in an oil bath; while in a tin bath the corresponding temperature was 508° Fah.

18. By carrying out this idea we have the clue to the action of water thrown, in considerable quantities, upon heated metal; and find, accordingly, that when the water was increased sixteen times, or from one-eighth of an ounce to two ounces, the temperature of most rapid vaporization was raised from 460° to 600° Fah.; the surface of the metal being smooth, and the heat supplied through tin. Now, although differences in the mode of applying heat will alter these temperatures, it is clear that they rise rapidly with the quantity of water thrown upon the metal. In the case where as much water was thrown into an iron bowl as it could contain without loss by ebullition, the temperature of greatest vaporization, upon a clean surface, was 600° Fah. or about 200 degrees below a red heat, and would, according to analogy, have been higher if on a rough, or oxidated, surface.*

19. These observations explain the direct experiments made by the Committee, in which highly elastic steam was always rapidly produced by injecting water into a boiler heated to bright redness.† In one case, by the injection of ten ounces of water the elasticity of the steam was raised, in less than two minutes, to upwards of twelve atmospheres, and a miniature explosion produced. The remarks made in this experiment show, that wherever the water slid along the bottom of the boiler the spot of contact was for the instant blackened, by the sudden reduction of temperature, and this under the unfavorable circumstance of the introduction of a limited quantity. The bottom of the boiler in these experiments was clean, but not bright. The time required for the generation of explosive steam under these circumstances does not yet admit of calculation, but this may be affirmed with certainty, that a safety-valve which, under ordinary circumstances, may be adequate to carry off the excess of steam produced in a boiler, will prove wholly insufficient for its escape, in the supposed case.

20. These experiments are entirely supported by well authenticated cases of explosions in steamboat boilers. Mr. Bakewell‡ gives an instance in the case of the steamboat Grampus, where six cylindrical boilers, each thirty-eight inches in diameter, exploded simultaneously. The engineer had discovered that they contained very little water, and had suddenly thrown in a plentiful supply. When one of the boilers of the steamboat Car of Commerce§ exploded, it was well known that the pumps had not furnished the requisite supply of water; and just after an attempt to remedy this difficulty, the head of one of the boilers was thrown off. This boiler was, it seems, differently constructed from the others, with which it was connected, and which did not give way.

The first of these cases is distinctly made out, and the second cannot be resolved into a matter of opinion, as may perhaps be done with other acci-

* Report of Com. on Expl. &c. Reply to Query IV. "Vaporization of increased quantities of water." Jour. Frank. Inst. vol. xvii. p. 160.

† Ibid. Reply to Query II.

‡ Letter to Sec'y. of Treasury, communicated to Com. on Expl. Reply to Circular of Com. No. XII. Also, Letter of Thos. J Haldermann, No. XXI. of Replies.

§ Letter of Thos. J. Haldermann, No. XXI. of Replies to Circular, &c.

dents, which, though there is a strong probability that they are to be traced to this cause, the Committee refrain from quoting.

21. It is, of course, not assumed that an explosion must necessarily follow the presence of heated metal; for other circumstances must conspire to produce such a result. Facts indeed, may be brought to show that, in certain cases, these attendant circumstances have been accidentally wanting, or have been judiciously avoided.

As examples of this, may be taken instances mentioned by Col. Long* in which timber on the top of cylindrical boilers has been known to take fire, though considerably remote from any fire-flue. Those to which Mr. Bakewell† has been an eye witness, when the steam has been so highly heated after leaving the boiler, as still to burn the hempen packing of the steam cylinder, and where wood contiguous to the boiler has been fired. Similar incidents not followed by explosions have occurred in the mines of Cornwall,‡ and in one of the Liverpool and Dublin packets.§ Examples of the second kind will be referred to subsequently.

22. With such a powerful agent present, as the highly elastic steam which it has been proved may be rapidly generated by the heated metal, it might have been supposed that no other cause for explosion would have been looked for, than the action of this steam. The case is, however, otherwise, and the Committee must turn aside from their direct course to examine briefly the theory which assigns the production, and subsequent destruction of hydrogen gas, as the cause of the explosion. According to this view, the water thrown upon the metal is decomposed, and hydrogen gas evolved; or a similar decomposition of the steam, by the hot metal, takes place. This hydrogen, becoming mixed with oxygen, is ignited by the red hot metal, and an explosion ensues. The difficulty of furnishing oxygen for the hydrogen to combine with, has lately been met more satisfactorily by Mr. Perkins, than it had been by any preceding theorists. He asserts that air is frequently drawn in by the operation of the forcing pump, and is thus accumulated in the boiler. The primary hypothesis, in regard to the production of hydrogen, having been fully disproved by the experiments of this Committee, there is no necessity for examining the minor ones; it may be well, however, to observe, that if air were introduced into a highly heated boiler, containing hydrogen in too large a quantity either to combine explosively, or silently, with the oxygen of the air, that element would be taken up by the heated metal; and that gases cannot enter, and remain without mixing with the steam, and being carried out with it. In the experiments of the Committee which have been referred to,‖ water was thrown upon the bottom of a boiler, heated to orange redness, without being decomposed. In fact the scale of oxide existing upon the bottom prevented the decomposition of water, by enfeebling the affinity which would

* Replies to Circular, &c. No. II.

† Replies, &c. No. XII.

‡ Mr. Perkins states on the authority of Mr. Moyle, that a ladder accidentally resting upon the top of a boiler, was set on fire by heat communicated from thence. Franklin Jour., vol. iii., p. 417, or Lond. Jour. Arts, vol. xiii., p. 95.

§ Evidence, before Com. of House of Commons, 1817. Hazard on Explosions. Frank. Jour. vol. iii. Ewbank on Explosions. Jour. Frank. Inst. vol. x.

‖ The reader should refer to these, that he may see the care which was taken in them. A negative result requires so much more caution than a positive one, that more time was devoted to those experiments in order to make them satisfactory, than the Committee deemed warranted by the importance of the subject. Report of Com. on Explosions, Part I. p. 61, &c. Jour. Frank. Inst. vol. xvii. p. 217.

produce it. This boiler was carefully cleaned, and in good working condition; a condition in which no one need be told, a boiler has not a bright metallic surface.

23. Carburetted hydrogen does no doubt exist at times in a boiler, in greater or less quantities, from the decomposition of oil, or of vegetable substances introduced to stop leaks, or to prevent deposites, but nothing warrants the idea that it can accumulate and mix with air, so as to be dangerous.

In furnaces where coal is used as a fuel, it will be seen in the sequel that gas, if prevented from escaping by the closing of a damper, may collect, and may possibly be a source of danger.* The ignition of a mixture of coal gas and air in a furnace has been known to destroy it,† as also of a mixture of gas from resinous wood and air; but these are cases altogether foreign from the subject under discussion.‡

24. The explosion of the steamboat Enterprise, on the Savannah river, is said to have occurred at the instant the boat was struck by lightning. This has been advanced as confirming the hydrogen hypothesis; but no inference can fairly be drawn from an accident, in regard to which the circumstances are so little known. If there was hydrogen present, there must have been unduly heated metal, and the direct action of electricity on the nonconductors around the boiler, may have so displaced it as to bring water upon the heated metal, and thus to effect an explosion. This, like the other supposition, is mere hypothesis. It is certainly, however, quite as contrary to analogy, that an electric spark should pass through any part of a space, like the interior of a boiler surrounded by a conductor, and thus explode a mixture of hydrogen and oxygen within it, as that it should shatter this extensive conductor by its direct action. The Committee consider the circumstances of this case as too illy defined to draw any inference from it, certainly not one which is contrary to sound theory, by which they mean general induction from numerous well observed facts.

25. Another case has been urged with much more appearance of directness in the testimony. A boiler in the Union rolling mills at Pittsburgh burst with a tremendous explosion; a cylinder with one of the heads attached, was thrown out of the works, and rising to a considerable height in the air, fell nearly two hundred yards from its former bed. A passenger in a boat which was near at the time, describes a stream of fire, as issuing from behind the boiler, which, according to the hypothesis under discussion, was a stream of burning hydrogen. It is almost needless to remark that if hydrogen had been the cause of the explosion it would not have burned in a stream behind the empty boiler as it rose; the observation is, however, perfectly well explained by Doct. Jones,§ by the stream of light which appears to attend every luminous substance moving rapidly, on account of the duration

* Explosion in the Gold mines as given by John Taylor, Esq. Philos. Mag. vol. i.

† M. Arago states this to be the fact on the authority of M. Gay Lussac. A furnace was thus destroyed at the Paris arsenal. Annuaire du Bureau des Long. 1830, p. 197, and Jour. Frank. Inst. vol. vi. p. 54.

‡ See the case of an explosion of a sheet-iron drum attached to an anthracite stove, with its explanation by Prof. Hare. Jour. Frank. Inst. vol. vi. p. 337. Pine shavings were used to kindle the fire, the gas from which, mixing with the air in the pipes and drum, produced an explosion, when the flame from the kindled shavings rose into it. Refer also to the explosion of the bellows of a smith's forge. Silliman's Jour. vol. xxiv. p. 192.

§ Jour. Frank. Inst. vol. iii. pp. 70, 71. "Editor on explosions in Steam Boilers."

of the impression upon the eye. That the boiler was red hot, there appears no doubt.

26. From this digression the Committee return to the pursuit of their subject. They conceive that it has been fully established, that the presence of unduly heated metal is dangerous, both from the weakness of the material, and the possibility of its producing highly elastic steam. They, therefore, proceed to examine the probable causes leading to this result, and which have been suggested either in the communications made to them or in other documents, and the proposed remedies for, or precautions against, the danger.

[TO BE CONTINUED.]

On the metallurgic treatment of the Galena of Bleyberg in Carinthia. From the French of M. BOULANGER, *Candidate, Engineer of Mines.**

A very simple and commodious method of treating galena, is pursued at Bleyberg, in Carinthia, the theory of which process forms an interesting subject of enquiry, and it was this which induced me to make the following analysis of the products of the various operations pursued at these works. I shall first give a short description of the operations, extracted from the journal of a tour made in this country in 1832–'33, by MM. Gruner Harlé and Foy.

The mineral employed at Bleyberg is galena, found in veins in limestone, of which two kinds are chiefly worked; in one of the beds the galena is accompanied by pyrites and blende, with traces of silver; the other contains pyrites likewise, but rarely blende, and encloses sulphate of baryta and molybdate of lead without a trace of silver.

The two ores are dressed with much care, and mingled in such proportions as to be of good quality; for in order to be worked to advantage, they ought to yield 65 or 70 per cent. in a small assay. When prepared for smelting, they contain a little pyrites, blende, sulphate of baryta and limestone.

The operations are conducted in a reverberatory furnace, eleven feet long and four and a half broad, (figs. 1, 2, 3,) parallel to the longer side of which is the fire place. The bottom is inclined at an angle of 25°; the fire place, formed of brick arches, at about 36°. The flame and smoke escape through the chimney, situated at the side of the charging hole. The bottom is formed of clay, old bottoms and refuse pounded together in a dry state; it is slightly cylindric in its whole length, forming a kind of trough in which the lead flows.

When the bottom is well beaten, it is fired for five or six days, the heat being increased towards the last, to soften it, and it is then smoothed.

Each operation for the reduction of the galena consists of three parts; 1. roasting, 2. raking, 3. the operation termed *pressen*, in which the lead is acted upon by air and charcoal.

1. *Roasting*. The furnace is charged with three quintals, twenty lbs.† of the washed ore of two different sizes and qualities, the mean product of which should be at least 70 per cent. lead. When the foregoing

* Translated at the request of the Committee on Publications, from Ann. des Mines, 3rd Serie, T. VII., by J. C. Booth.

† The quintal is 221 lbs. avoirdupois, English, and the French lb. about 2lb. 3oz. TRANS.

operation is complete, the furnace is suffered to cool for a quarter of an hour, and then charged with the ore, which is spread uniformly by an iron *rake*. The heat is maintained at incipient redness to avoid the fusion of the sulphuret, and ought to be lower, in proportion to the purity of the material, because its tendency to fuse is diminished by the infusible nature of the matrix. It is stirred up every half hour by an iron rod, the handle of which rests on a hook suspended by a chain; not however, too frequently, for that would retard the roasting.

Fig. 3. *Fig.* 2

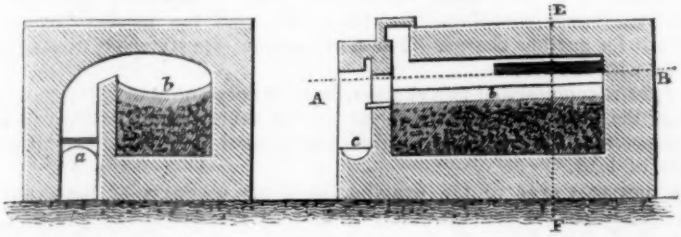


Fig. 1.

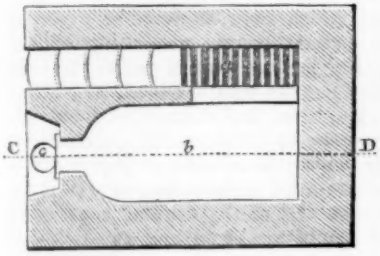


Fig. 1. is a horizontal projection along A, B, of *Fig.* 2. *Fig.* 2, a vertical section through C, D, of *Fig.* 1, and *Fig.* 3, a vertical section through E, F, of *Fig.* 2. *a*, represents a fire place arched with bricks, *b*, is the sole, and *c*, the basin to receive the lead.

This first operation lasts from four to five hours,* during which the temperature is gradually raised, and that without inconvenience, since the fusibility of the material diminishes in proportion to its oxidation; besides which an elevation of temperature causes a re-action, producing lead which often begins to flow out in a couple of hours. The heat ought not, however, to be carried so far, that the lead comes red from the furnace. This is called virgin lead, and is received into an iron vessel placed beneath the charging hole.

2. *Raking* or *Stirring*. While the roasting is going forward, the fire is increased to cause a more energetic re-action of the materials, causing the lead to flow abundantly. The workman frequently stirs the mineral by spreading it out, and again bringing it into a heap, and at length pushes it down to the bottom of the furnace, where the heat is more intense, at the same time surrounding the charging hole with blazing wood. This second part gives with the first, two-thirds of the lead, and when, notwithstanding the *stirring*, the lead ceases to run, the next operation follows.

3. The *Pressen* is only performed every second smelting, because it produces but little lead and requires much fuel, besides which the ore is diminished in bulk. When the second operation is completed, the refuse, called the rich scrapings (krätze), is taken out; fresh ore is added and treated like

* According to Villefosse, six to seven.—Trans.

the first; the first refuse is then added to the last, they are spread over the bottom of the furnace, and several shovels of live coals taken from the fire place, scattered over it. The workman mixes the whole by means of the iron rake, pushes it to the bottom of the furnace, increases the fire and stops the charging hole with blazing faggots. The lead flows out, and upon its ceasing, the workman again spreads out the pile for roasting, after which he adds more charcoal and brings the whole again into a heap. This alternate oxidation and reduction is continued till there are no longer traces of lead.

This operation lasts three hours, and when completed, the residue, termed the "poor scrapings," is taken out, and the bottom beaten to prepare it for another charge. The poor residues are stamped, washed and mingled with the ore.

One *poste*, composed of two charges, lasts twenty-one hours, during which one and the same workman performs all the labor, who afterwards rests for two *postes*. Each poste gives from four quintal, forty lb. to four quintal, sixty lb. of lead.

We now pass over to the examination of the products of these operations. The roasted ore taken out of the furnace before being stirred, is composed of a slightly caked, sandy mass, showing only a fusion of the lead, when subjected to a high heat in an earthen crucible. With black flux it gave 50 per cent. metallic lead, which gave no trace of silver by cupellation. This substance is very heterogeneous, presenting oxides, unchanged galena, and metallic lead, the greater part of which may be separated by stamping and sifting. The powder thus obtained, was boiled with water, which dissolved sulphuric acid, lime, and oxide of lead; the lime was present in larger quantity than was necessary for saturating the sulphuric acid, and to this excess was probably owing the solution of lead with sulphuric acid. But did sulphate of lime pre-exist in the mass, or was it not rather afterwards generated by the action of water? In order to ascertain this, I boiled water with a mixture of sulphate of lead and caustic lime, and found that all the acid was dissolved, together with a certain quantity of lead, which varied with the quantity of lime and water employed. The acid might, therefore, have existed in the state of sulphate of lead, and only combined with lime through the interposition of water; but since the sulphate of lime is more fixed than that of lead, the same might have occurred in the dry way, and the salt of lime have been formed in this case likewise; it is hence impossible to say in what state of combination the sulphuric acid existed.

Boiling acetic acid extracted from the remainder, insoluble in water, lime, oxide of lead, and protoxide of iron.

From this remainder, hydrochloric acid disengaged sulphuretted hydrogen. Having ascertained that silica was dissolved, which would be in a gelatinous state, I thought it advisable to extract this by means of liquid potassa, before the use of hydrochloric acid; the decomposition of the sulphurets might be apprehended by this means, and possibly a small portion of oxide of lead, found in solution in the potassa, arose from decomposed suphuret, for an excess of sulphur was found by analysis; but without doubt the greater part of the oxide pre-existed in the substance in the state of oxisulphuret, and could not be taken up by the acetic acid.

The residue insoluble in potassa was treated with hydrochloric acid, and the liberated sulphuretted hydrogen received into ammoniacal nitrate of copper; an analysis of the resulting sulphuret gave the quantity of sulphur

contained in the metallic sulphurets; the hydrochloric solution contained iron, zinc and lead.

The residue insoluble in the hydrochloric acid contained a little lead, which was taken up by weak nitric acid, and added to that obtained by sifting. Lastly, roasting the last residue gave a little sulphur from its loss of weight, and there remained only sulphate of baryta, as was ascertained by an analysis with carbonate of potassa in a silver crucible.

According to this analysis, the roasted ore is composed of

Oxide of lead,	0.310
Sulphuric acid,	0.023
Lime,	0.042
Oxide of iron,	0.004
Sulphuret of lead,	0.225
" iron,	0.022
" zinc,	0.069
Sulphur,	0.002
Silica,	0.016
Sulphate of baryta,	0.034
Metallic lead,	0.233
	0.980

It follows from this analysis, that the roasted ore is principally composed of metallic lead, its sulphuret and oxide, for even supposing all the sulphuric acid to be in the state of sulphate of lead, still there would be but 8 per cent. of it; now the roasting process, in heaps, generally gives a larger quantity of this sulphate; it is the more remarkable that the roasting in a reverberatory furnace gives rise to so small an amount, because it is performed in this case at a very low temperature, exposed to a current of air that ought to be highly oxidizing; in fact, the very inclined position of the fire place creates a current of air, which mingles with the flame above the fire, independently of the one below it; besides, in order to enter the furnace, the flame is obliged to pass through an opening only four inches in height, (an arrangement analagous to the smoke-consuming furnaces of M. Lefroy) necessarily causing an eddy and a consequent mixture of the air and combustible gases, which ought to deprive the latter of every deoxidizing property; notwithstanding these circumstances, so favourable to the production of a sulphate, but little is formed. It appears to me explicable in the following manner.

The first effect of the roasting is to produce oxide of lead, which tends to unite with the sulphuric acid generated; the production of this sulphate ought therefore to be in proportion to the quantity of free oxide; now in a reverberatory furnace, the oxidation takes place superficially, and the oxide is in contact with the unchanged sulphuret beneath it; a reaction occurs, with the consequent production of metallic lead, while very little oxide is formed; it is hence easy to perceive that too frequent raking would produce a large quantity of oxide, part of which would be converted into sulphate, because the reaction could no longer as easily occur; and we have seen, that at Bleyberg, the surface is renewed every half hour.*

In roasting in heaps, the ore is put in layers alternating with charcoal, where reaction would only take place between the substances in the same

* The theory may be stated thus: the basic sulphate of lead forms with the unchanged ore a pasty mass, a lower sulphuret than galena, from which the lead flows, by a conversion of a part into a higher sulphuret.—Trans.

layer, but as all are equally exposed to the oxidizing current, they are soon roasted in an equable manner, and the production of sulphate ought consequently to be considerable. In fact, by comparing the quantity of sulphate produced by roasting the same ore in heaps, or in a reverberatory furnace, we shall find these suppositions verified; at Holzapfel, for instance, roasting in heaps produces 19 per cent. of sulphate, in a reverberatory 8 per cent.; at Pezey, in the one case, 65 per cent. of sulphate is obtained, while the other operation produces none. Roasting in reverberating furnaces offers therefore, great advantages, since it generates the least possible amount of sulphate.

By exposing the roasted ore to a strong heat, a reaction is caused between the oxide and the sulphuret, with the production of a fresh quantity of lead, an operation termed stirring (Bleirühren).

The resulting "rich scrapings" have absolutely the same appearance as the roasted ore, containing, like it, metallic lead imbedded in the mass, and through the whole are perceptible brilliant scales of galena. Assayed with black flux, they give 51 per cent. metallic lead, which leaves, by cupellation, a button of unalloyed lead.

An analysis of this substance, made in the same manner, gave the following results:

Oxide of lead,	0.305
Sulphuric acid,	0.037
Lime,	0.116
Oxide of iron,	0.012
" zinc,	0.038
Sulphuret of lead	0.061
" iron,	0.029
" zinc,	0.074
Silica,	0.028
Sulphate of baryta,	0.051
Metallic lead,	0.183
	0.934

An examination of the above analysis will show that this substance differs but little from the roasted ore, for it is nothing more than a product of roasting, except that the oxides are present in larger quantity from the nature and length of the process. By comparing the lime with the sulphate of baryta, it will be perceived that this base has nearly doubled. Can this be attributed to the want of homogeneousness of the substance, or may we not rather suppose, that a small quantity of lime has been added during the process, (which is sometimes done,) either to saturate the sulphuric acid, produced in abundance by continued roasting, or to diminish the fusibility of the substance exposed to a more elevated temperature during the stirring process?

The "rich scrapings" yield no more lead by a simple reaction, because a part of the oxide undoubtedly forms with the sulphuret, an oxisulphuret, on which the oxide does not act; it is, therefore, necessary to have recourse to charcoal for reducing the latter and liberating the sulphuret; by again roasting it, the newly generated oxide acts on the sulphuret, and thus by successive reductions and oxidations, the scrapings are exhausted of nearly all the lead. The charcoal has also the effect of rendering the mass porous and offering channels to the metallic lead imbedded in the mass for flowing into the iron receivers; indeed, both the preceding substances contained much metallic

lead, while the "poor scraps" now remaining, are almost wholly destitute of it.

This residue differs from the preceding in not containing metallic lead, and in presenting a more homogeneous appearance. Heated with black flux, it yields 5.7 per cent. of lead, which gives a button of silver by cupellation, much larger than that of the rich residue.

It contains no sulphuric acid except in combination with baryta; the analysis was conducted by first treating it with acetic acid, and then the operation was continued as in the preceding materials; there was found as in the preceding cases, it is composed of:

Oxide of lead,	0.020
Lime,	0.318
Protoxide of iron,	0.062
Oxide of zinc,	0.154
Sulphuret of lead,	0.050
" iron,	0.038
" zinc,	0.138
Silica,	0.056
Sulphate of baryta,	0.148
Metallic lead,	0.012
	0.996

It is apparent from this analysis that the charcoal had the effect of destroying the oxide and sulphuric acid; the sulphate of baryta is, however, unaltered, which probably arises from the great resistance to decomposing agents, which natural bodies present.*

It is also worthy of remark, that this last product encloses a considerable quantity of sulphuret of zinc, the more surprising as blende is generally the first to be roasted.

Another not less remarkable anomaly relates to the silver contained in the ore, the quantity of which is small, but while the lead obtained during the first process, gives no indication of it, it is found in the other products, particularly in the last. We must, therefore, conclude, though contrary to what generally occurs, that the silver is concentrated in the last products.†

This refuse yields no more lead, because the great amount of oxidized matter prevents the ulterior oxidation of the sulphurets; instead, however, of rejecting them, they are stamped, washed and mixed, with the crude ore.

From the preceding it may be gathered that the process pursued at Bleyberg is very simple, consisting in the transformation of a part of the sulphuret into oxide, in causing these to act on each other to produce lead, and lastly, in setting the sulphuret again at liberty to enable the fresh oxide to act upon it.

During the whole of this treatment, the substances are merely softened, and preserve their sandy state, which is favorable to the successive oxidations and reductions that could not be performed on liquid or pasty masses. Care is also taken at the commencement, to heat moderately to avoid smelting the galena, and to raise the temperature gradually, and only

* The sulphate of baryta is at all times difficult of decomposition, and should be in immediate contact with the decomposing agent, which may not be the case in the above operation. Would it not, however, be decomposed if a sufficient quantity of charcoal were present?—Trans.

† It is to be regretted that the author has not presented us with an accurate analysis of the metallic lead obtained during the different stages of the process, as it might give us valuable hints in regard to theory and practice.—Trans.

in proportion as the sulphuret diminishes, for then the fusion of the substances is not to be feared.

As already stated, the roasted ore, or the scrapings, subjected to a bright red heat in a clay crucible, did not undergo fusion, which must be attributed to the sulphate of baryta, and to lime, for probably the lime added during the process, is peculiarly adapted to that purpose. This is directly opposed to the ideas of M. Tournet (in a note in Ann. des Mines, 3e, Série, T. II. "Théorie du traitement de la galèna au réverbère,"), who asserts that sulphate of baryta is added in Carinthia, to promote the fusion of the gypsum which is generated. The assertion is incorrect, for the heavy spar is found in the matrix, and if aught be added, it is lime, not however, for the purpose of rendering the gangue fusible, for it is important to prevent it, and by this very means the end is attained, for, according to Berthier, (Ann. des Mines, 3e Série, T. II.,) the sulphates of lime and baryta do not form a fusible combination.

There remains 7.3 per cent. lead in the "poor scrapings," the amount of which, retained by the different combinations it forms with foreign substances, ought of course to increase with these. A tariff is employed at the works regulating the loss of lead according to the productiveness of the ore.

When the ore contains 82 per cent. the loss should not exceed 2 per cent., 80, 3; 78, 4; 76, 5; 74, 6; 72, 7; 70, 8; 68, 9; 66, 10; 64, 11; 62, 12; 60, 13.

The poor residues were formerly treated alone, with a loss of 20 per cent. The workmen receive $2\frac{1}{2}$ kreuzer, (2 sous) for every pound they obtain beyond the tariff, and pay 5 kreuzer for every pound wanting. The table shows that the loss increases in rapid proportion, as the quantity of ore diminishes, the consequence of which is, that only very rich ores can be employed in this process, and indeed they only receive such as give 50 per cent. in a small assay.

In order to bring the different ores to a convenient state of richness, they are subjected to preparatory mechanical operations, and very carefully washed; hence the work would be expensive with a high price for labour; at Bleyberg, however, a day labourer receives a very moderate compensation. It were impossible to make the ore productive in many places, even supposing wages to be very low; it is when the metallic substances accompanying the lead, such as the blende and pyrites, contained silver, in which case all these substances should remain in the ore. It follows, therefore, that the process of Bleyberg ought to be limited to certain localities, where, as in Carinthia, the contents of silver amount to almost nothing.

With regard to the advantages derivable from the Carinthian method, they are considerable, when taken in connexion with economy of fuel, as may be shown by a comparison of it with the analagous process pursued at Poullaouen. At Bleyberg eleven to twelve cubic feet of wood are consumed in obtaining the quintal of lead. According to a treatise of M. Baillot, they obtained at Poullaouen, in 1824, from an ore containing 60 per cent. lead, only 42 per cent., showing a loss of 30 per cent.; but this loss is not real, for a part of the lead is obtained on an ore hearth, though it then requires another operation. The loss at Bleyberg for ores containing 60 per cent. is only 13 per cent. In order to obtain one quintal of lead, forty-seven to forty-eight cubic feet of wood are consumed, or four times as much as at Bleyberg. Again, they destroy six pounds of iron instruments per quintal; at Bleyberg, on the other hand, only one-fifth of a pound; this arises from the

formation of much sulphate during roasting, which, being afterwards decomposed by the charcoal and iron, converts the latter into sulphuret. The Carinthian method possesses, therefore, great advantages, being convenient and easy of execution, requiring only one workman during a *poste* of twenty-one hours, the consumption of fuel and loss of lead being inconsiderable. But only small quantities can be operated on in this manner, for in twenty-one hours the amount of lead produced, does not exceed four and a half or five quintals, French. At Poullaouen, they obtain in the same time, or even in eighteen hours, twelve to thirteen quintals.

It is probable that the employment of a large furnace in this method, would destroy its advantages, the facility of labour and economy of fuel; in fact, at Poullaouen, the greatest expense for fuel is incurred during the reducing process, when the temperature must be very high, although the furnace is considerably enlarged by a diminution of the substances. At Alsau and Holzapfel, they likewise employ the Carinthian method, operating only on small quantities.

Physical Science.

ESSAYS ON METEOROLOGY.

No. IV.

North East Storms, Volcanoes, and Columnar Clouds.

If all other proofs were wanting, our great N. E. storms of six or eight hundred miles in diameter, from N. E. to S. W., and of unknown extent from S. E. to N. W., would afford us an undeniable proof of an upward vortex. These storms always set in from near the N. E. and terminate near the west. So we have proof positive, that the wind near the surface of the earth, is always blowing both east and west of the storm towards the storm itself. I have observed these storms for many years, and I have never known but two to terminate with the wind from the eastern quarter, and then the anomaly was soon explained in both instances, by another storm coming on in less than forty-eight hours. But even in these cases, after the termination of the first storm, the wind was very gentle, nearly calm.

The wind always commences from the N. E., some hours (from ten to forty) before the beginning of the rain or snow, and does not change till near the end: however, it is believed that the upper clouds during all this time, continue to come from the S. W.

They certainly do so till they are concealed from view by the lower clouds, which generally form a short time before it begins to rain, and the moment the lower clouds break away a little, near the end of the storm, the upper clouds are seen moving in the same direction. Besides, I have more than once got a peep through the lower clouds, during the progress of a storm, and discovered thick, dense, clouds above, coming from the S. W.

I have also seen instances of a strong wind at the surface, directly opposite to the motion of dense clouds above, which were evidently not very high, from their great velocity, and I afterwards learned that at the same moment there was a very great rain about one hundred miles distant, in the direction towards which the lower wind was blowing. The extent, however, of these rains, I did not learn. It must depend upon future and more extended observations, to learn whether the outward motion of the air in

the upper part of the vortex, extends beyond the boundary to which the inward motion of the air below reaches.

On the ocean, it is known that these storms are attended with immense swells reaching beyond the agitation of the atmosphere. This effect is probably much more dependent on the diminished pressure of the atmosphere on the ocean under the vortex, than on its horizontal velocity. For a fall of three inches in the barometer will cause a rise of the water of more than three feet to produce equilibrium, and as the waters would move in all directions towards the point of least pressure, their momentum would cause a rise two or three times this quantity independent of the effect caused by the friction of the air. How far the reciprocation of this wave would extend, I am not at present able to say. I think I have read of considerable elevations of the water, at one end of the lake of Geneva, which were evidently not produced by the wind blowing over the surface of the lake in a direction favourable to such an elevation; if there was a spout passing, near the time of the elevation, it would account for the phenomenon. Indeed, if the spout should even pass over the middle of the lake, and the barometer should fall there three inches, it would cause such a swell that its reciprocations would reach its extremities after the spout had passed away, and thus these swells would appear to take place in the midst of a calm, and so be apparently unconnected with the wind. Mr. Dalton informs us that the surface of Lake Derwent is sometimes agitated, when no wind can be perceived, in so violent a manner, that it exhibits large waves with white breakers. The phenomenon is called a bottom wind; but the cause of it is utterly unknown. Lake Wetter, in Sweden, is affected in a similar manner.* The theory of upward vortices shows how such an effect might be produced.

Even as to the barometer itself, I have not seen any theory which is able satisfactorily to account for its great and sudden falls. It cannot be the diminished pressure which takes place from the deposition of rain, for if ten inches of rain were to fall so suddenly that the air would not have time to rush in and restore the equilibrium, it would not cause the barometer to fall one inch.

Indeed, so great has been the difficulty on this point, that the author of the Art. Physical Geography, in the Edinburgh Encyclopædia, thinks these depressions are caused by the destruction of large portions of the air in the higher regions of the atmosphere by electricity acting on the combustibles which ascend there from the earth. I need hardly add that this phenomenon is a corollary from the theory here advanced.

It has been thought also, that the centrifugal force of the wind blowing over the curvature of the earth's surface, might cause these great depressions of the barometer. But if we suppose the whole of the air in motion with a velocity of one hundred miles an hour, and calculate its centrifugal force according to the principles laid down before, its gravity would be diminished when the wind was west, only about one hundred thousandth of its whole weight, which would cause the barometer to fall .0003 of an inch; and if the wind is east, it will readily be perceived that its gravity will be increased to the same amount. The theory will also account for the great depression of the barometer, which is known sometimes to accompany the action of volcanoes.

On the 19th of December, 1821, a violent eruption commenced from the old volcano Eyafjeld Jokkul, in Iceland, which had been quiet since the year 1612. On the very day of the commencement of the eruption the

* Ed. Ency. Art. Physical Geography.

waters of the rivers which descended from the surrounding mountains, were considerably increased. All over Europe dreadful storms of wind, hail and rain succeeded the commencement of this eruption. On the 24th, particularly, extraordinary devastations were experienced in very distant parts of Europe, and generally, wherever the hurricane appeared, deluges of rain accompanied it. At Genoa, and many other parts of Italy, the storm is described as particularly severe, (wind S. and S. E.,) many parts of the country and the roads being entirely submerged; and the next day, the 25th, the barometer fell unusually low all over Europe, including Great Britain. Now it is highly probable, that the eruption of the volcano threw out immense quantities of vapour, and if so, the condensation of this vapour would heat up the atmosphere by the evolution of its latent caloric, as was explained before, and this heated air would rise and spread out in all directions; and a vortex being thus established and kept up by the action of the volcano, both by mechanical force and by a diminution of specific gravity, the air rolling out on all sides above, and pressing in on all sides below, a general rain would be the consequence, and this rain might spread out so far from the centre of action, as to reach even the south of Europe in five days. The barometer continued to fall, in Iceland, from the day before the appearance of the volcano, till the twenty-sixth day after it was at the lowest in different parts of Europe, and two days after the prevalence of great storms in Italy and France. During all this time the volcano was in active operation, and even as late as the 23rd of February, it emitted smoke greatly resembling steam of boiling water. The whole quantity of rain which fell from the 19th till the 24th, must have been very great; for even as far south as Genoa, the air, for several days previous to the 24th, when the great tempest occurred there, had been filled with thick vapours, which vented themselves in torrents of rain, and the wind blew from the south with intense violence. This south wind would bring from the Mediterranean an immense quantity of vapour, to be condensed when it entered into this vast upward vortex. Let us suppose then, what is certainly within bounds, that five inches on an average of rain, fell over the surface of Europe, from the 19th till the 24th, or the morning of the 25th; and in Paris, where the flood was not as great as in many other places, there fell 6.4 inches. From the principles explained before, the caloric given out by the vapour in condensing into rain, would heat the whole atmosphere 11.4° for every inch of rain, or in the present case 57. degrees. And as the mean temperature of the air was certainly below 32° the expansion due to this increase of temperature would be more than $\frac{57}{480}$ of the whole, which would cause the air to stand at its surface five and a half miles higher over the region where the rain had been deposited, than in surrounding countries, provided it was forty-five miles high before the deposition, and none had flowed off.

This last supposition, however, cannot be true, for the moment it began to swell up by expansion, it would begin also to flow off, and the depression of the barometer would be in proportion to the quantity rolling off above, greater than that which ran in below towards the point of least pressure. This difference would be considerable for two reasons: first, the air below would not begin to run in until the air above had rolled out; for a mere expansion and swelling up of the air would not diminish its gravitation; and second, its resistance would be less from friction than the lower air would experience rubbing along the surface of the earth. Besides, its outward motion from the centre of the vortex, would not so much be a rolling

down an inclined plane in consequence of its being swelled into a greater perpendicular height, as a shoving out of the surrounding air at an elevation of about three and a half miles and upwards, where the air in the vortex would overbalance the surrounding air, as will easily be conceived by any one who will consider the effect of an up-heaving of the atmosphere by expansion. From all these causes facilitating the outward motion of the upper air in the vortex, it is probable that at least one half of the quantity of air elevated in the vortex above the surrounding air, by expansion, would flow off, and if so, it would cause a depression of the barometer, within the region of the rain, of more than one inch and a half. And this corresponds with the depressions given in many places.

This depression would cause a velocity of the air at the surface of the earth, on the outside of the vortex, towards the centre of rarification, of 114 miles per hour, if there was no friction; but as the friction at the surface of the earth is very great, the velocity would probably not be more than one half this quantity, or fifty-seven miles per hour. This velocity would not be sufficient to produce the overflowing of the sea at Genoa, Leghorn and Trieste, but if to the force of the wind, we add the diminished pressure of the air along the northern shore of the Mediterranean and of the Adriatic, and the increase of the pressure of the air on the outside of the storm, by the rush of the air outwards above the rise of waters, there might be quite sufficient to produce the disastrous effects which spread consternation over so much of the southern part of Europe.

Was the remarkably warm winter of 1821 and 1822, in all the north of Europe, caused by the immense quantity of latent caloric given out during these great rains, together with the southern winds which prevailed in consequence of the upward vortex of air over Iceland during this whole winter? At St. Petersburg, dreadful floods of rain repeatedly occurred during the winter, and the snow had entirely disappeared by the first of February; and even beyond Tobolsk, warm winds prevailed, and generally in the interior there was no snow. And on the 2d of March, the Dwina was free from ice at Riga.*

If this were the only fact on record, of rain accompanying volcanoes, it ought in this case, to be considered accidental and unconnected, but nothing is better established than the connexion of volcanoes with rains, from their very frequent concomitancy. Indeed, Baron Humboldt, speaks of the mysterious connexion of volcanoes with rains, and adds, that they sometimes on breaking out change dry seasons into rainy in South America. This connexion will be considered mysterious no longer. It may here be added as a reason why volcanoes do not always produce rains, that in the most unfavourable state of the dew-point, rains cannot be produced.

Volcanic eruptions are sometimes attended with tornadoes. In the Island of Sumbawa, eastward of Java, a most dreadful volcanic eruption commenced from the mountain of Tomboro on the 5th of April, 1815, and was most violent on the 11th and 12th. Out of a population of twelve thousand persons only twenty-six escaped destruction. Violent whirlwinds swept away men, horses, cattle, and every thing which came within their vortex, tore up the largest trees, and covered the neighbouring seas with floating timber, that had been scorched in passing through the flames.

These volcanic vortices sometimes carry up the drops of rain high enough to freeze them. The Rev. W. B. Clarke, says in the Magazine

* See Phil. Journals of 1822.

Nat. Hist. vol. vii, page 300, "that Mr. Kelsall, who was an eye witness of the great eruption of Etna in 1809, writes thus: At fifteen minutes past 9 A. M., April 1st, a quantity of dense vapour or smoke proceeded from two rents, which rose to a considerable height in the atmosphere, before serene, was dilated, and formed a black cloud above 2000 paces in diameter, which presently discharged a copious shower of large hail stones, on the red hot lava. In the same page he says, that during an eruption of a volcano in Iceland, in 1793, not only did rain fall in torrents, but also hail in showers.

Mr. J. R. Jackson, in his Aide-Memoire Du Voyageur, says, "I have seen in the planes of Agra, Hindostan, Lat. 27°, enormous columns of sand, sometimes thirty at a time, several feet in diameter, rising perpendicularly out of sight, and followed frequently by a shower of large hail stones, containing such a quantity of sand in large grains, that in filling a goblet with this hail, when it was melted, there was a sediment of sand almost half an inch thick.

From these accounts it is manifest that hail is sometimes produced by an upward motion of a column of air, both with and without volcanic agency. That snow is produced, and even not permitted to fall down in the region of the upward motion when that motion is very rapid, is abundantly proved by the following facts:

In Scoresby's Arctic Regions, vol. I, page 404, the author says, "About 10 h. the snow abated, and several ships were seen about three or four miles off. As all these ships were sailing on the wind, it was very easy to ascertain the direction of the wind where they were. Two ships bearing N. E. from us had the wind N. E.; two bearing E. at E. or E. N. E.; two bearing S. E. had the wind S. E. while with us it blew from the N. W.

In each of these places a fresh breeze prevailed; but in some situations where there happened to be no ships, there appeared to be no wind at all. The clouds above us at the time were constantly changing their forms, and showers of snow were seen in various places at a distance." At another time, he says, "while a gentle breeze from N. prevailed with us, a heavy swell from the S. S. E. came on, and a dense black cloud appeared in the southern horizon, which rapidly rose into the zenith and shrouded one half of the heavens. The commixture of this dense air with the cold wind from the N. produced a copious discharge of snow. When the snow ceased, (though we were nearly becalmed,) we observed several ships a few miles to the south-eastward under close-reefed topsails, having evidently a gale of wind, blowing in the direction of the swell. In about two hours the southern wind reached us, and as we stood to the eastward, gradually increased to a gale. Previous to this storm the barometer fell three-fourths of an inch in twelve hours. Now as the wind in both these storms blew towards a particular point from all sides round, it must have blown upwards at and over that point, and hence the snow was not permitted to fall there, but fell at "various places at a distance."

It is equally clear, that a strong gale could not blow towards Captain Scoresby in sight of him for two hours, before it reached him, without blowing upwards at some point between him and the ships seen labouring in the gale.

A remarkable circumstance, which I think can only be explained on the supposition that the cloud mentioned moved upwards, is related in the next page. He says, "my father was engaged on a particularly fine day in admiring, from an eminence of 2000 feet on Charles Island, the extensive prospect, when the rapid approach of a small cloud attracted his attention;

When it reached the place where he was setting in a calm air, a torrent of wind assailed him with such violence that he was obliged to throw himself on his body and stick his hands and feet into the snow, to prevent himself from being hurled over a tremendous slope which threatened his instant destruction. The cloud having passed, the air again became calm, and he immediately descended." Now this is just the effect which a large mass of air would produce by moving upwards rapidly, from being of less specific gravity than the surrounding air, which is too plain to need demonstration.

This cloud was probably formed in the following manner: Air at the surface of the ground below became heated, as it always does in clear, calm days, some degrees hotter than the air a little above the surface, and thus produced an unstable equilibrium, so that the least agitation would cause an upward motion to commence at the point of greatest heat, especially if that point contained a higher dew point, as it generally does. As soon as this motion commenced, other air rushed in below, and the higher and longer the column of heated air became, the more rapid would the upward motion become, and finally, after the upper end of the column was as many hundred yards high as the temperature of the air on the ground was above the dew-point in degrees of Fahr., the cold produced by the expansion of the air, would begin to condense the vapour and form clouds; and still as other air rose to that elevation it would begin to condense likewise, and thus the base of the cloud would remain at the same elevation, while the cloud would go on increasing in perpendicular height above. This is the kind of cloud which is formed almost every clear day in the summer when the dew-point is not very low, but never forms when it is over cast. When the air is calm, if these clouds are observed carefully when they are forming, they will be seen to increase in perpendicular height while their bases remain at the same level. They rise in the form of pyramids or cones, with dense, well-defined outlines, as white as snow. If they do not meet with an upper current causing their tops to lean in the direction in which it is moving, they rise perpendicularly, and as they are broad enough even at their tops to lift up before them a considerable mass of air, it sometimes happens that in reaching strata of air highly charged with vapour it lifts them to a higher elevation and causes a thin streak of cloud to be formed at some distance above the top of the columnar cloud. This streak so formed I have denominated a *cap*. It is generally a little curved convex above and concave below, and as it moves slower upwards than the columnar cloud, the latter overtakes it and passes through it. Meanwhile the cap appears like a thin vapour spread over a mass of snow. Sometimes when a columnar cloud is very strong and rapid in its ascent a second and even a third cap is formed, with similar appearances. When this happens, rain from the cloud is certain. First, however, the top of the cloud is seen to change its dense and well-defined appearance and become hazy. This is a sign that the cloud is about to rain, and in a few minutes, if the cloud is favorably situated, rain will be seen descending from its base. These appearances are all best seen when the base of the cloud is a few degrees above the horizon. The top of the cloud as it hazes is generally, in this climate, carried off by the upper current towards the N. E. and forms that feathery cloud which is so different in appearance from all other clouds. It is the highest of all the clouds except the tops of these columnar clouds, which generally rise through it.

In passing through it the columnar clouds generally form a very dense cap, and are sure to haze and rain soon after their passage. After they

begin to rain they soon cease to rise; but other columns spring up contiguous to them, generally on the S. W. side of them, as far as I have observed, and as theory seems to indicate, and go through the same process of cap-forming, hazing and raining as the parent cloud.

These new columns when they first make their appearance I have denominated *sprouts*. This name is not inappropriate, for these sprouts are evidently generated, or at least assisted in their growth, by the parent column, in the following manner. As the parent column rises into the upper current of air, which generally comes from the S. W. or W. S. W. its top is made to lean towards the N. E. or E. N. E., but by its inertia it causes the current there to run a little slower, and so the column which may be about to form behind it towards the S. W. finds less difficulty in rising, and preserves a more erect position, and thus can attain a greater elevation. Hence, the first attempts of columnar clouds to rain are generally failures, because their tops are generally shaved off or pressed over towards the N. E., and thus dissipated without raining: each succeeding cloud in its wake finding a stiller air in its upward motion attains a greater elevation. Finally, one reaches a height sufficient to produce rain, and then a new source of power is called into action, powerfully aiding the formation of sprouts. This is the descending rain cooling the air below the cloud, and causing it by its greater specific gravity, and also by the weight of the drops of rain, to move outwards in all directions from the centre of the rain.

Now as the air all round the parent cloud is running in at the base of the cloud and below towards the cloud, this air is obliged to rise up over the stratum of cold heavy air, pressed outwards around the borders of the shower, and thus its upward motion is increased; and as the dew-point is more likely to be higher on the south side of the cloud than on the north, sprouts will on that account be more likely to form on the south than on the north. To see the formation of sprouts to the greatest advantage then, the cloud should be to the north of the observer.

If these theoretical deductions are correct, and as far as observation extends it does not contradict them, it would follow, that the progress of rain may be from a northern direction, though the upper current may be constantly carrying the hazy cloud formed from the tops of all these columns towards the east. Further observations are wanting on this point.

I would recommend that gentlemen residing in mountainous districts, where the clouds sometimes form on the sides of the mountains, should ascertain the perpendicular height of these clouds at their base, and see whether they are one hundred yards high for every degree of Fahr. which the temperature of the air is above the dew-point at the moment of their formation.

If gentlemen have no means of taking the dew-point directly, the following method will be found equally correct in ascertaining the height of the base of these particular clouds, at any time of the day, for the height varies every hour. Swing a thermometer (Fahr.) rapidly in the air to avoid the effect of radiation, note its temperature, then cover its bulb with a wet rag and swing it as before until it sinks as low as evaporation can make it, then divide one hundred and three times the difference of these temperatures by the wet bulb temperature, the quotient will be the height of the base of the clouds in question, in hundred yards. For example, suppose the dry bulb is $56\frac{1}{4}°$ and the wet one $51\frac{1}{4}°$, then the base of the clouds will be 1000 yards high. This height is calculated on the supposition that air cools at 4° Fahr. in

ascending to a height where the barometer would be one inch lower than at the surface of the earth, and 4° more for every additional inch. If this latter law is not strictly correct, the height of the base of the cloud in question will vary accordingly, and the law itself may be accurately investigated by this method, for the precise degree of refrigeration necessary to condense vapour at a particular dew-point is known, after making an allowance for the expansion of the vapour itself and the fall of the dew-point on this account. As the discovery of a method to ascertain by the thermometer, the height of a particular kind of cloud easily distinguishable from all others, is a matter highly curious in itself, independent of its connexion with the theory here advocated, it will no doubt receive that immediate attention which it deserves.

Franklin Institute.

Committee on Science and the Arts.

Report of Committee to try experiments with Spark Arresters.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, by experiments, the apparatus for stopping the sparks from issuing from the flues of Locomotive Engines, submitted in competition for the premium offered on behalf of the Newcastle and Frenchtown Turnpike and Rail Road Company, REPORT:—

That, from the plans submitted in competition for the offered reward, they selected three of the most promising, which they recommended the respective inventors to put in order for trial; at the same time they informed the other competitors that theirs also would be tried, if they requested it.

Through the liberality and kindness of the Beaver Meadow Rail Road Company, and the Philadelphia and Trenton Rail Road Company, the Committee have been favored with the use of the engine of the former, and of the road of the latter for making their experiments. One of the plans selected having been withdrawn, and none of the others claiming the privilege of a trial, there remained but two to be subjected to a practical test, viz: one invented by Jas. P. Espy, Esq. and the other by Mr. S. Gerhard.

The one by Mr. Gerhard, consists of a series of revolving fan wheels placed horizontally one above the other near the top of the chimney or smoke pipe, the wheels or fans were placed nearly in contact one above the other, having just sufficient space to admit of motion independently of each other, and the twist of the fans reversed in the middle one, so that its revolution should be in the opposite direction from the other two. The revolving motion to be produced after the manner of a smoke jack, by the current of air and steam passing up the chimney.

This apparatus was first put upon the engine and the fire attempted to be made, but it was found that owing to the too small capacity of the passage through the fans, the firing was difficult and tedious, and that it was impossible to keep up the steam for a moderate velocity of the engine and tender. The effect in arresting the fire sparks was rather unexpected, as not a single spark was seen to make its escape, although care was taken to use such fuel as would furnish them in the greatest profusion. This result could only be ascribed to one of the three following causes, either the ope-

ration of the fans had been effectual in beating back and destroying the sparks, or as the engineer who accompanied the Committee supposed, the obstruction to the draft being great the steam was necessarily so damp as to extinguish them, (and being in the night time they were invisible,) or what was considered highly probable, the obstruction was so great as to prevent the creation of an upward current sufficiently powerful to raise the sparks to the top of the chimney, and that any other obstruction operating in the same degree, would be attended with the same results. Accordingly, at a subsequent trial, a piece of sheet iron eight inches wide was secured across the top of the smoke pipe leaving an opening on each side three and a half inches wide, with the intention of making about the same amount of obstruction as had been caused by the before mentioned fans. The result of the experiment was nearly similar. The obstruction in the latter case was evidently, from other indications, not quite so great as in the former, and a very small number of sparks occasionally made their appearance. Whilst the committee acknowledge that their experiments go no farther than to show that the favorable results obtained by the inventor, previously to his submitting it to the examination of the Committee, and that obtained by the Committee as above mentioned, may have been owing rather to its efficacy as a *draught obstructor*, than to any good principle of action as a spark arrester, they can see no good reason for advising the inventor to incur the further expense of constructing one of larger dimensions, being persuaded that one of sufficient capacity to allow a free passage of the smoke and escape steam, would be attended with little or no impediment to the sparks.

The apparatus, called a draft-increasing chimney cap, invented by J. P. Espy, Esq., is of sheet iron, in the form of a cone, and is placed upon the top of the smoke pipe, with its axis horizontal and its lower side pierced about midway to receive the upper end of the pipe. The base is open with the exception of a wire-gauze covering, which is intended to retain the sparks within the cap. It is intended to turn upon a swivel and be governed by a vane, so as always to present the apex of the cone towards the wind: the intention of which arrangement is to create a partial vacuum at the base of, and within the cone, to compensate for the obstruction consequent upon the use of the wire-gauze. The Committee upon trial, found that this apparatus did produce the effect of increasing the draught to some extent, but although the gauze used was of the finest kind in use, No. 19, or 19 meshes per inch, yet the sparks found their way through in sufficient quantity to be troublesome. How far the draft-increasing property of this cap may operate, to compensate for the resistance of the gauze, when that shall be of sufficient fineness to effectually prevent the escape of sparks, the Committee have not the means of judging with any degree of precision, but they incline to the opinion that the compensation would not be complete without such an arrangement as would render the apparatus inconvenient if not unmanageable, particularly on roads which require the pipe to be dropped for passing under bridges. An objection arises from the circumstance of the sparks, dirt and water, when any such escape, being thrown backward, and consequently more likely to incommode the engineers, than when discharged from the top upward, and all around the sides. There seems, likewise, a want of some means of disposal of the sparks arrested, as they are necessarily retained against the gauze until they become so much reduced by combustion as to be forced through it, and likewise of a trap or valve to remain open when the draught is not urged by the exhaust steam. Upon the whole, the Committee are of the opinion that this arrester

does not come within the terms and conditions of the offered premium, and though they confess, that the trials have not been sufficiently numerous and diversified to enable them to speak with certainty as to its comparative merits, yet they feel constrained to say, that they do not perceive how the objections already alluded to, can be so far removed as to bring it into competition with one or two which have been since invented.

The thanks of the Committee are due to Messrs. Garrett and Eastwick, for their kindness in keeping the locomotive, at their own risk, for the accommodation of the Committee.

By order of the committee.

August 11, 1836. WILLIAM HAMILTON, *Actuary.*

Mechanics' Register.

AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED IN FEBRUARY, 1836.

With Remarks and Exemplifications by the Editor.

(CONTINUED FROM p. 195.)

59. For *Sawing with a Band Saw;* William Carey, Poughkeepsie, Dutchess county, New York, February 17.

The patentee claims as his invention, "the band saw running on two wheels, and the arrangement of the machine in which it is to operate." For the validity of which claim, see our remarks upon the patent of Benj. Barker, p. 112 of the present volume; every remark respecting which applies fully to the present patent.

60. For *Cannon for firing chain shot;* Edward Gordon, Hingham, Plymouth county, Massachusetts, February 17.

A double barrelled cannon is to be made, one vent discharging each. A ball is be put into each gun, the two being connected by a chain of sufficient length to admit of this. The guns are to diverge a little, in order to stretch the chain before the balls reach their intended object. There is not any claim made, but the patentee descants on the use of his invention, and the destructive effects of balls so connected, as though chain shot had never been used. Now it certainly behooves a man, before he attempts to improve a system of any kind, to acquire some knowledge of what has been previously done, for, when science and interest have long been combined in order to obtain the best results, it rarely happens that an indifferent person will stumble upon any great improvement, all vulgar adages to the contrary notwithstanding.

We do not know that chain shot have been fired from double barrelled cannon, nor do we believe that they ever will. We offer the following opposite quotaion from "L'Allemand's Artillery." "The Annals of Paris and Vienna alone, are crowded with contrivances, all curious in their way, but offering models that do more credit to the imagination than to the judgment of their authors. Among a thousand inventions, or fancied improvements, it is difficult to find a single one that has not already been made and

condemned; and even if it be new, it cannot be admitted into a system until it has been submitted to practice during the course of a war."

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61. For a *Machine for hulling Clover Seed;* John B. and William F. Poague, Lexington, Rockbridge county, Virginia, February 17.

A conical stone is to revolve is a corresponding hollow cone of the same material. The mode of fixing, driving, &c., are all quite antique; and the claim is to the "before described machine;" which claim may be perfectly correct, if by the before described machine, we are to understand a machine which has been repeatedly before described.

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62. For a *mode of fastening Mail Bags, &c.;* Ira Atkins, Hanover, Grafton county, New Hampshire, February 17.

There is to be a lock, with a bolt, shot forward by a key in the usual way, but to the end of the bolt is to be hinged a flat plate of iron, which is one of a series hinged to each other, and forming a chain, or flat strap, each plate has a tongue on it which is to shoot into a staple; a row of such staples being fixed on one side of the bag, and passing through openings on the other side. The claim is to the whole arrangement, with the exception of the ordinary lock bolt. The contrivance appears to us to be one which will be more troublesome than useful.

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63. For a *Mortice door latch;* William Coover, Erie, Erie county, Pennsylvania, February 12.

This mortice latch, or bolt, presents no feature of novelty, nor is any part of it claimed. It consists merely of a bolt with a zigzag spring behind it; the bolt being contained in a suitable case, and having a tumbler, and handle, by which it is to be acted upon.

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64. For a *Spark Extinguisher;* Abraham McDonough, City of Philadelphia, Pennsylvania, February 17.

In this spark extinguisher there is to be a lining of sponge within the cap which constitutes the upper part of the chimney, and this lining is to be kept wet by the percolation of water through small tubes in the bottom of the trough, which is fixed at the upper edge of the cap; there is to be a water trough also at the lower end of the cap, into which sparks are to fall. The description and drawing, although not models of clearness, may suffice to enable a shrewd workman to construct the apparatus, but there is not any thing to guide us to a knowledge of what is claimed; it cannot be the use of water, and the lining of the cap, as these are not new, and this lining and upper trough may, according to the patentee, be omitted. We are apprehensive, however, that amending the specification would not remove the main difficulty, as it will not enable the machine to attain the proposed end, which we very much doubt its ability to do.

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65. For an improvement in the manner of *raising and depressing the steam and exhaust valves of Steam Engines;* William Duff and Thomas Murphey, City of Baltimore, Maryland, February 17.

The object of this arrangement appears to be to operate upon the induction and eduction puppet valves by rods acting in a direct line. The claims are, "First, the arrangement of the valve-stem in the top-chest, in an inverted position, so as to be connected by means of the rod with the

stem of the valve of the lower chest, in a direct line. Secondly, the connection by means of the straps, as set forth, of the stuffing box of the female stem of the top chest, which box is also inverted, so as to be thus connected in a straight line with a stuffing box of the lower chest; and, finally, the adaptation of the two connected rocking shafts as described, to produce by means of the lifters and lugs, the alternate motion of the stems and straps."

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66. For an improved *Tire for Carriage Wheels;* James H. Rogers, Mount Morris, Livingston county, New York, February 17.

The tire is to be made hollow on the inside, so that its cross section shall present a curve, or two straight lines, forming an obtuse angle in the centre. "The use or application of the hollowed or grooved tire, for the purpose of carriage and other wheel building generally," constitutes the claim.

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67. For an improvement in the *Manufacture of Starch;* Walter and Thomas Leveredge, Dorchester, Norfolk county, Massachusetts, February 17.

"We claim a patent for manufacturing starch from rice, or for the application of rice as a substitute for other substances heretofore used in the manufacture of starch." Whether so broad a claim as this can be sustained is a very doubtful point. Rice is the principal food of a very large portion of the human race, and is, by millions, eaten to the exclusion of nearly every thing else, and that among a people who use starch largely in their manufactures; we have not at hand, or in memory, any direct information on the subject, but the probabilities are much against the absolute novelty of the manufacture.

The process followed by the patentees, but not claimed, is the following: fifty pounds chloride of lime are dissolved in one hundred gallons of water, and to the liquid when drawn off clear, eight pounds of sulphuric acid are added. Upon any quantity of rice as much of this liquor is to be poured as will just cover it, and it is to remain, with occasional stirring, for forty-eight hours. The liquid is then to be drawn off, and the rice ground, with water, to about the consistence of cream. To every one hundred gallons of this liquid, as much water is to be added, after which it is to be strained through a bolting cloth, to be allowed to settle for twenty-four hours, the clear liquid drawn off, and the starch dried.

We do not understand the chemistry of this proceeding, the first step of which is to make, and to destroy, a solution of chloride of lime.

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68. For a *Rotary Steam Engine;* Aaron Clark, Bangor, Penobscot county, Maine, February 17.

The construction of this engine is, in nearly all its parts, the same with that of many others of the rotary kind. A stationary and a revolving cylinder are employed, the latter being within the former, and furnished with two sliding valves capable of being forced into the body of it, by that portion of the outer cylinder which projects into the chamber for that purpose. These valves are widened on that edge which is within the inner cylinder, and upon these ends the steam is admitted, and is, by its pressure, to force them out. The claim is to "the mode in which the floats are forced out and into the revolving cylinder." The advantages pointed out

by the patentee are the same as those anticipated by the projectors of rotary engines generally, and, generally, terminating in disappointment.

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69. For a *Truss for Hernia;* William Adair, Pleasant Hill, Monroe county, Kentucky, February 17.

A straight strap, partly of leather, and partly of India rubber, is to pass round the body, and to have on it a wooden pad, covered with buckskin. Two narrow straps are to be used to keep it in its place, one passing round the thigh, and the other over the shoulder. This truss, we are told, "causes a pressure in the direction of the *abdominal canal*, [qu] by the inelastic hard wooden pad, thus effecting a permanent adhesion of the parts, &c." The claim is to "the before described truss." Such a truss is worthy of such a claim, as it is not distinguishable by any novel or good feature.

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70. For an improvement on the *Paper making machine;* Charles Forbes, administrator of Robert Rose, deceased, East Hartford, Hartford county, Connecticut, February 20.

An endless webb of wire fourteen feet long, is to pass round two rollers so situated that the upper surface of the webb shall form an inclined plane; eighteen or twenty small rollers are used to support this webb on its under surface, and the lower end is to form a part of one end of a vat containing the paper stuff. The claim is to "the sustaining the webb in a slanting position, so as to form the end, and in part, the bottom of the vat containing the stuff, or pulp, so that the pulp, by means of the water draining through the webb, may be properly deposited on the webb for the formation of paper."

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71. For an improvement in *Spectacle glasses;* Isaac Schnaitman, Northern Liberties, Philadelphia county, Pennsylvania, February 20.

Many persons have been in the habit of using segments of two glasses in each eye of spectacle frames, the segments being of different focii, so as to adapt them to distant or near objects. The patentee, instead of having divided glasses, grinds each glass so as to have two focal centres, and claims "the invention of grinding two separate and distinct focii in one piece of glass, adapted to various optical purposes, but principally to be used and applied as spectacle glasses."

We think this specification imperfect, inasmuch as it only informs us respecting the end attained, and leaves us in the dark as regards the means of arriving at it; the decisions say that a patent cannot be sustained for a result merely, but that it must be granted for the means of accomplishing it; and it will not be pretended that glasses, such as are here described, can be ground by the ordinary tools, or by the ordinary manipulation.

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72. For a *machine for Sawing Staves;* Aaron Bard and Simeon Heywood, Lunenburg, Worcester county, Massachusetts. First patented July 8th, 1834. Patent surrendered, and re-issued February 20.

We noticed this patent at page 93, Vol. xv, and mentioned the existence of a previous one for the same thing. The patent has been surrendered for the purpose of claiming those particular things in which the present patentees view their improvements as consisting; namely, "the manner of running the saw on friction wheels, lapped by each other; also the flanch,

or flanches, to keep the saw from running off its bearings; also the slide boxes for the axles of the friction wheels to run in and set them to the saw."

The saw is a complete hoop, which was included in the patent of Sumner King, noticed in Vol. xiii, page 121, and believed to be new; if this opinion was correct, it is presumed that the present patentees have acquired a right to it, without which their improvements would be of no value.

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73. For *Supplying Salt;* Peter Cooper, New York.

This has been registered in the Patent Office by mistake, the patent not having issued; and it is to be hoped that it never may, as the plan proposed is one which caps the climax of absurdity, being no other than to convert the water of our canals into brine, in order that salt may thereby find a cheap and easy conveyance.

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74. For an improvement in *Suction and Forcing Pumps;* Thomas C. Barton, Washington, Warren county, New Jersey, February 20.

This patent is not taken for any improvement in the principle of construction, but for certain modes of putting the parts together; these improvements are described as to be applied to a double cylinder pump, such as is generally employed in fire engines, and without the drawings an attempt to describe them would demand too much space and time for the subject matter.

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75. For *Hollow Cylindrical Flyers,* to be used in manufacturing yarn and thread; Samuel Ladd, Waltham, Middlesex county, Massachusetts, February 20.

The *hollow cylindrical flyers,* is merely a cylinder which surrounds the spindle, in the manner of the cap spinner, and we are unable, from the description, claim, or drawing, (or rather scratching,) to discover where the novelty, or invention, lies.

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76. For a *Saw Mill wherein hand saws are used for cutting off cross sections of wood;* Rufus Ricker, Dexter, Penobscot county, Maine, February 20.

The claim made is to "the described combination of levers to moving hand saws, (either one or more,) for sawing cross sections of timber or other substances." It does not appear, however, that the cross cutting is to be effected by *hand saws,* but by frame saws, moved by a combination of levers not specially meriting a description.

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77. For a *Wash for curing fever sores, King's evil, and most kinds of old sores;* Reuben Rood, Lisle, Broome county, New York, February 20.

"Take 2½ drams of blue vitriol, 4 drams of allum, 6 drams of loaf sugar, dissolve them in one pint of good vinegar; add three table spoonsful of honey, and the mixture is fit for use. Keep the sore clean, and wash it twice a day with the above mixture until completely healed."

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78. For an improvement in the art of *Constructing Clocks;* William Pardee, Poughkeepsie, Dutchess county, New York. First patented May 22d, 1835. Patent surrendered, and re-issued February 25.

A notice of this instrument, as originally patented, is contained in Vol. xvi,

page 401. In the present patent the title is changed from an improvement in the *construction of time pieces*, to that of *the art of constructing clocks*; this is certainly no improvement in nomenclature as the affair is not a clock, there not being any striking movement whatever, but simply a watch, or time-piece, movement. The following is the claim now made, or, which is the same thing, an exposition of what are deemed its characteristics.

"The principle of this improvement consists essentially in this, that it is a combination of a clock movement, in which the force is applied to the arbor that carries the minute hand, substantially as aforesaid, whence the force is communicated by wheels and pinions to the hour hand, and to the pallet wheel, where it is regulated by a pendulum of any convenient structure, with a clock case, or front, cast in any convenient form, in one piece, substantially as aforesaid. The force may be by weight and pulleys, or by spring."

That which appears to be considered an essential difference between this and other time pieces, namely, the application of the power to "the arbor that carries the minute hand," is not new, this having been done by Dr. Franklin in a time piece of his contriving. See article "Clock" in Rees' Cyclopædia, and most other works treating upon Horology.

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79. For a *Copper Still*, for the purpose of running alcohol from whiskey. First patented October 22d, 1834. Surrendered and reissued February 20.

This patent is taken for an improvement upon a still patented in Europe, and known under the name of Saintmarc's still. The claims to improvement consist in "the particular manner of arranging the tubes and caps throughout the series of chambers, and the addition of the first, or goose neck, condenser, and its appurtenances, in the manner, and for the purposes set forth." The original still has been figured and described in the English Journals, and those interested in such matters may learn its construction by consulting them; the improvements would require a drawing for their illustration.

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80. For a *machine for Thrashing out Clover, and other small seeds;* James Cooper, Greene county, Ohio, February 20.

A cylinder is to be made of wood, armed with strips of iron, which are to rub the seeds against a concave placed under it; the concave is to consist of straw, broom-corn, or other fibrous substances placed endwise in a box, and compressed firmly together, the surface of which must, of course, be cut into such a form as will adapt it to the cylinder. The claim is to "the mode described of making the concave, or bed, of straw, broom-corn, split wood, bristles, split whale bone, or of other similar materials; also the mode of ironing the cylinder."

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81. For a *Winnowing Machine;* David Wilson, Johnson, Franklin county, Vermont, February 20.

This is denominated a *horizontal* winnowing machine, and it receives this name, we suppose, from the fan being made to revolve horizontally, to do which its shaft is acted on by bevel gear. This appears to be the only thing about it which stands a chance of being called new, and even this, it seems, was, correctly, accounted unworthy a claim, which extends only to "the arrangement and adaptation of the several parts of the before described horizontal winnowing machine."

82. For an *Injection Apparatus;* Joseph Ralph, New York, February 25.

A very formal description is given of this instrument, which is intended for administering injections in diseases of the urethra. It consists of an India rubber bag, with an ivory female screw tied in the mouth of it, which is to receive a stopper, to retain the water put into it, "which water is intended to be converted into a lotion by the admixture therewith of certain powders prepared for this purpose." Other letters patent are to be obtained for these *certain* powders, of which due notice will, no doubt, be given and properly displayed, in the public newspapers.

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83. For a *Truss for Hernia;* Francis Hollis Newman, Huntsville, Alabama, February 25.

In this truss the main novelty consists in making the pad of some flexible material which is impervious to air or water; which pad is to be kept distended by one or other of those fluids. Where pressure is required from a less yielding material, a cap of metal is to be placed over the pad. The particular manner of confining the pad to the body is described, but in this there is not any thing worthy of notice, or differing materially from what has been frequently done. A claim is made to the application of pressure by means of liquids or gases, whether combined or not with the use of hard substances.

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84. For an improved *Lathe for turning Gun Stocks;* Abner Town, Woodbury, Caledonia county, Vermont, February 25.

We are informed that "the construction of the improved lathe or machine is such that both the guide and fly wheels remain stationary, while, in the operation of turning, the pattern and block pass them; whereas in the original gun stock lathe, those wheels are movable and pass the pattern, and block, both of which remain stationary. Also, in the improved machine the pattern and block have each a separate mandrill turned by a wheel, which is not the case in the original lathe. Also the machinery attached to the carriage in the improvement is such as to produce a rocking motion instead of the swinging motion of the original lathe, &c."

We cannot attempt a verbal description of the differences pointed out in the foregoing abstract, which is to be considered as constituting the claim.

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85. For *Sawing by Lever Power;* Jeremiah Walker, Philips, Somerset county, Maine, February 25.

A pulley on a double crank shaft is connected by a strap or band to another carrying a circular saw. The two cranks on the first shaft are in opposite directions, and each of them is connected by a pitman to a horizontal lever under the frame work, so that these levers may work up and down like treadles: one of these levers is made long, and is to be worked up and down by hand, the other is short, and is loaded with a weight at its vibrating end; as the long lever is forced down the weight is raised, and as the long lever is raised, the other, with its weight, descends. This constitutes the whole affair, and he who does not pronounce the contrivance for continuing the power, greatly inferior to that of the ordinary fly wheel, knows but little of machinery.

86. For a *Cooking Stove;* Billy Titus, of Marshal, Oneida county, and Anson Titus, of Phelps, Ontario county, New York, February 25.

The claims made are to "the application of a tin or sheet iron, baker or cover, for the purpose of baking or cooking on the movable hearth, in the manner specified; and the application of a box stove of very small size, and in its simplest and cheapest shape, to cooking, as described." The stove and its fixtures appear to us so much like many others, that we cannot venture to tell what is meant by the foregoing claims.

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87. For a *Vibrating Pump;* Sampson Davis, Derby, Orleans county, Vermont, February 25.

The patentee says, "what I claim as new, is a new improvement of principle in the method of raising and conveying water, by means of the *vibrating pump.* I claim no more." This new application of principles consists of a small overshot wheel, supplied with water in the usual way, and having a crank upon one end of its shaft, which is to work the piston of a small force pump. The cylinder of the pump is made to vibrate, like that of the vibrating steam engine, and the water is to be delivered through a flexible hose, admitting thereby of a free vibration.

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88. For a *Spark Consumer;* Francis Milo, Albany, New York, February 25.

The specification and drawing of this apparatus do not render its construction clear, and the claim to "the before described apparatus" does not lend any aid in "distinguishing the same from all other things before used or known."

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89. For a *Smut Machine;* Abraham Mudge, Canajohaire, Montgomery county, New York, February 25.

"The principle which I claim to have applied to the purpose of cleaning grain from smut and other impure substances, by means of the machine above described, and which application I claim to have invented, is that of throwing the grain by means of wings, or flanches, attached to a circular plate as above described, against some hard substance with sufficient force to break smut balls, &c."

This apparatus appears to be very well calculated to effect the proposed object, and to blow off the dust from the smut and other sources, but the form of the claim is objectionable, as the same principle has been before applied for attaining the same end, and it is the particular method of applying the principle, alone, which is the proper subject for a claim.

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90. For an improvement in the *Saw Mill;* David Worthington, Peru, Berkshire county, Massachusetts, February 25.

The saw used is to be furnished with teeth on each of its edges, and is to cut the stuff as the carriage travels in either direction. There are to be two rag wheels with teeth in opposite directions, and two feed hands, one for each wheel; the double toothed saw is not new, and is not claimed as such, the claim being confined to the particular arrangement adopted for moving the rag wheels; a thing in which there is no difficulty whatever, every machinist knowing methods of accomplishing this object, which no patent can prevent him from employing.

91. For a *Bee House;* Ebenezer Beard, New Sharon, Kennebec county, Maine, February 25.

The claim made is to "the manner of constructing and arranging the hives and boxes within the house, and the manner in which the bees communicate therewith." We have no doubt that the arrangement described, is convenient and beneficial, but we do not think that it is sufficiently distinguished, in the description, from other similar contrivances, to admit of a claim so general.

92. For a *machine for Washing and Pressing Clothes;* Caleb Angevine, City of New York, February 25.

The claim is to "the circular wash cask; the manner and mode of applying the steam; the dog or other animal power to the cylinder; together with the formation of the horizontal press, and also the perpendicular lever press, as described in the specification."

We cannot say much for the novelty of the individual things claimed, as will be evident from a brief description. There is a boiler with a furnace under it, and a steam pipe leading from it into a horizontal cylinder, within which the clothes are to be placed, and agitated by dashers, made to revolve by a winch, in the ordinary way. The pressing is effected by placing the clothes within a cylinder, and forcing them together by means of a piston, or follower; the application of dog power, is, we apprehend, a mere embellishment, giving some life to the affair.

93. For an improvement in the *Cotton Gin;* Henry Clark, Montville, New London county, Connecticut, February 25.

This improvement consists in making the iron ribs between which the saws pass, in two thicknesses, the front being of steel, and attached to the iron by screws. The claim is to "the making the ribs in two parts, so that they can be easily detached and repaired."

94. For a *Floom Gate;* Harvey Frink, Hanover, Chautauque county, New York, February 25.

We have read the description of the floom gate which forms the subject of this patent, but the drawing has been mislaid; the former without the latter, would not be clear, and we shall not, at present, therefore, venture any opinion respecting the affair.

95. For an *Instrument for determining the variation of the needle, the true meridian, and the apparent time;* William A. Burt, Mount Vernon, Macomb county, Michigan, February 25.

The graduated arcs of circles, and the other appendages used, must be placed upon a circumferentor, or other analagous instrument, furnished with a level. The particular construction of the parts might be made known by verbal description, did we think proper to give the necessary space and time, but these we cannot now afford. There is nothing in the principle which would be new to the scientific observer; the only novelty being the particular arrangement of its parts.

96. For *Saw Mill Dogs;* Martin Rich, Caroline, Tompkins county, New York. First patented, March 6th, 1834. Surrendered and reissued February 25.

This patent was originally noticed under its proper date, since which it has been discovered that the claim made was too broad, and it is now limited to what appears to be new in the invention.

97. For *Saw Mill Dogs;* Phineas Bennet, Hector, Tompkins county, New York. First patented December 2d, 1834. Patent surrendered and re-issued February 25.

The observations upon the preceding patent apply to this also; they are now both owned by the same individual, and parts of the two are combined in practice. The owner of them, by assignment, is Chas. E. Handy, Esq., Ithaca, New York.

98. For an improvement in *Fire Arms;* Samuel Colt, Hartford, Hartford county, Connecticut, February 25.

This appears to be a very ingenious application of the revolving breech, to pistols, and other fire arms. The description is of considerable length, and refers throughout to numerous figures which are necessary to the understanding of the particular construction and arrangement of the parts. The claim, alone, would not afford any correct ideas respecting them.

99. For an improvement in the *Boot Tree;* Mathew Mathews, Wayne county, Ohio, February 25.

The members of the craft if they feel an interest in the peculiarities of this last of the boot trees, must apply at the patent office for a copy of the specification and drawing, the latter being necessary to the understanding of the former.

100. For a *House Warmer;* O. Kindrick, and W. Elwell, Gardiner, Maine, February 25.

A hollow box of iron is placed across the back of the fire place, with a tube from one end of it leading into a cellar, or other place, for a supply of cold air, the other end being furnished with a tube to conduct the heated air into the room; this latter tube is to pass to some distance up the chimney, where it is to be elbowed, so as to admit the heated air into the room; and the patentees say, "what we specifically claim as our improvement, and for which we ask an exclusive right, is the making of, and applying a box, cistern, or cockle, as above described, to a common fire place, fire frame, or stove, for the purpose of heating, or warming, rooms."

This plan is equally old, and inefficient. Would it not be well to add a dog wheel, or some other motive power, to force air through the tube by means of a blowing apparatus?

Progress of Physical Science.

Formation of Æther. By M. Mitscherlich.

The decomposition of alcohol into æther and water is not interesting merely by the production of æther, but is especially so as an example of a particular kind of decomposition, which cannot be so well followed with any other substance, and which is manifested in the formation of some important products, for example, in that of alcohol itself. M. Mitscherlich has endeavored to elucidate the phœnomena of this decomposition by the following

experiments: Take a mixture of 100 parts of sulphuric acid, 20 of water, and 50 of anhydrous alcohol, and heat it gradually until its boiling-point becomes 284° Fahrenheit. Alcohol is then allowed to fall gradually into the vessel which contains the mixture, and the current is to be so regulated that the heat of the mixture remains constantly at 284°. If, for example, the operation be conducted with a mixture of six ounces of sulphuric acid, one ounce and one-fifth of water, and three of alcohol, and if the density of each two ounces of product as it is obtained be taken, it will be observed that this density passes gradually from 0.780 to 0.788 and 0.798, and afterwards remains constantly at the last mentioned density, which is exactly that of the alcohol employed.

If the operation be properly conducted, an unlimited quantity of alcohol may be converted into æther, provided that the sulphuric acid does not change. The distilled liquor is formed of two distinct fluids; the upper one is æther, containing a little water and alcohol; the lower one is water with a little alcohol and æther. Its weight is nearly equal to that of the alcohol employed, and it is composed of

Æther, ...	65
Alcohol, ...	18
Water, ...	17—100

If into six ounces of concentrated sulphuric acid six ounces of pure alcohol are suffered to flow gradually, a product of constant density is not obtained until the sulphuric acid has taken its proportion of water. Take, on the contrary, three ounces of sulphuric acid and two ounces of water, and let alcohol be added, drop by drop; the first two ounces distilled are merely spirit of wine, of specific gravity 0.926, containing scarcely a trace of æther. The density decreases until the quantity of water of the sulphuric acid is reduced to its proportion, and the product of the distillation has acquired the density of the alcohol. If concentrated sulphuric acid be added to anhydrous alcohol in excess, pure alcohol distils at first; but when the temperature reaches nearly 260° the first traces of æther begin to appear; the production of æther is at its maximum between 284° and 302°.

It results from the preceding observations, that alcohol when in contact with sulphuric acid, is converted into æther and water at a temperature of about 284°. A great number of analagous decompositions and combinations are known which may be attributed entirely to the influence of the contact of bodies. The most remarkable example of this kind is that of the conversion of oxygenated water into water and oxygen, by the slightest trace of the peroxide of manganese and some other substances. The decomposition of sugar into alcohol and carbonic acid, the oxydizement of alcohol when it is changed into vinegar, are phœnomena of the same kind; and so also is the conversion of starch into sugar by means of sulphuric acid. M. Mitscherlich, observing that in the preparation of carburetted hydrogen by means of sulphuric acid and alcohol, water is formed at the same time, attributes this decomposition of alcohol to the influence of mere contact, and not to the affinity of sulphuric acid for water.

Journal de Pharmacie, Juin, 1835, & Lond. and Edin. Philos Jour.

"Report of Magnetic experiments tried on board an Iron Steam-Vessel, by order of the Right Hon. the Lords Commissioners of the Admiralty." By Edward J. Johnson, Esq., Commander, R. N., accompanied by plans of the vessel, and tables showing the horizontal deflection of the Magnetic needle at different positions on board, together with the dip and magnetic

intensity observed at those positions, and compared with that obtained on shore with the same instruments.

This report commences with a description of the iron steam-vessel, the "Garryowen," belonging to the city of Dublin Steam Packet Company, and built by the Messrs. Laird, of Liverpool. She is constructed of malleable iron, is 231 tons burthen, and draws only $5\frac{1}{4}$ feet water, although the weight of iron in the hull, machinery, &c. is 180 tons.

The experiments having been interrupted by a continuance of wet and stormy weather, the author proceeds to draw the following general practical conclusions, deduced from the series of observations already made, and points out the further experiments which he considers necessary to be tried.

1st. The ordinary place for a steering-compass on board ship is not a proper position for it in an iron steam-vessel.

2nd. The binnacle-compass in its usual place on board the Garryowen is too much in error to be depended upon.

3rd. In selecting a proper position for a steering-compass on board iron steam-vessels, attention should be paid to its being placed, as far as is practicable, not only above the general mass of iron, but also above any smaller portions of iron that may be in its vicinity; or such portions of iron should be removed altogether.

4th. The steering-compass should never be placed on a level with the ends either of horizontal or perpendicular bars of iron.

5th. The extreme ends of an iron vessel are unfavorable positions, in consequence of the magnetic influences exerted in those situations. The centre of the vessel is also very objectionable, owing to the connecting rods, shafts, and other parts of the machinery belonging to the steam-engine and wheels, which are in continual motion; independently of the influence exerted by the great iron tunnel in this part of the ship.

6th. No favorable results were obtained by placing the compass either below the deck, or on a stage over the stern.

7th. It was found that at a position of $20\frac{1}{2}$ feet above the quarter-deck, and at another $13\frac{1}{4}$ feet above the level, and about one-seventh the length of the vessel from the stern, the deflections of the horizontal needle were less than those which have been observed in some of His Majesty's ships.

The author proceeds to point out various methods of determining, by means of a more extended inquiry, whether the position above indicated, or one nearer to the deck, is that at which the steering-compass would be most advantageously placed.

The concluding section contains an account of some observations made by the author on the effects of local attraction on board different steam-boats, from which it appears that the influence of this cause of deviation is more considerable than has been generally imagined; and he points out several precautions which should be observed in placing compasses on board such vessels. Proceedings Roy. Soc. Lond. and Edin. Philos. Mag.

Hydraulic Lime. M. Vicat communicated a paper to the Royal Academy of Sciences at Paris, on the sole efficacy of magnesia in rendering certain limestones hydraulic. This paper has for its object the correction of an opinion given by M. Berthier in the Journal des Mines of 1832, that magnesia alone has no more efficacy than alumina to render lime hydraulic; from which it would follow that silex was the only essential principle in all cases.

M. Vicat was for a long time of the same opinion, which he now declares incorrect; and says that magnesia alone, when in sufficient quantity, will

render pure lime hydraulic. He does not explain the degree of energy of these new species of lime, but only affirms that they will solidify from the 6th to the 8th day, and continue to harden in the same manner as ordinary hydraulic lime.

Until his experiments are further advanced, he states that the proportions of magnesia taken and weighed after calcination, should be from 30 to 40 for every 40 of pure anhydrous lime. The native limestones examined and cited by M. Berthier contained only from 20 to 26 of magnesia for every 78 to 60 of lime: it is probable that this want of proper proportions was the cause of his negative results. M. Vicat, in conclusion, points out the importance of these observations,—hydraulic lime never having been found in the calcareous formation below the lias, is because the dolomites have never been examined, but it is now probable it may be found in this lower formation. L'Institut, No. 153., and Lond. and Ed. Phil. Mag.

Liquefaction of Sulphuretted Hydrogen. Mr. Kemp discovered a very beautiful process for the liquefaction of sulphuretted hydrogen: he found that if dry persulphuretted hydrogen be introduced into a liquefying-tube, it slowly resolves itself into liquid protosulphuretted hydrogen, whilst sulphur in crystals is deposited. If previously there has been introduced into the end of the tube iodine in a dry state, then the protosulphuretted hydrogen, when it comes over upon it, dissolves it rapidly, and a dark yellowish brown coloured liquid results. If now to this there be added the least possible proportion of water (which is accomplished by a peculiar bend in the tube), instant reaction takes place, sulphur is deposited, and hydriodic acid in a most condensed and liquid state results. It is only necessary that a trace of water be present to commence the decomposition of the former brown compound, which I suppose to be the hydrosulphuret of iodine; for when this once commences, it goes on to any extent, and the liquid hydriodic acid formed may be called almost anhydrous. It boils by the heat of the hand like other condensed gases; it is of a yellowish colour, and resembles somewhat liquefied chlorine. Lond. and Edin. Philos. Mag.

Experimental Researches in the laws of the motion of Floating Bodies. By J. S. Russell. It was the object of these inquiries to assist in bringing to perfection the theory of Hydrodynamics, and ascertain the causes of certain *anomalous facts* in the resistance of fluids, so as to reduce them under the dominion of known laws.

The resistance of fluids to the motion of floating vessels is found in practice to differ widely from theory, being, in certain cases, double or triple of what theory gives, and in other and higher velocities, much less. These deviations have now been ascertained to follow two simple and very beautiful *laws:* 1st. A law giving a certain *emersion* of the body from the fluid as a function of the velocity. 2nd. A law giving the resistance of a fluid as a function of the velocity and magnitude of a wave propagated through the fluid, according to the law of Lagrange. These two laws comprehend the anomalous facts, and lead to the following results:

1. That the resistance of a fluid to the motion of a floating body will rapidly increase as the velocity of the body rises towards the velocity of the wave, and will become greatest when they approach nearest to equality.

2. That when the velocity of the body is rendered greater than that due to the *wave*, the motion to the body is greatly facilitated: it remains poised on the summit of the wave in a position which may be one of stable equilibrium; and this effect is such that at a velocity of nine miles an hour the resistance is less than at a velocity of six miles behind the wave.

3. The velocity of the wave is independent of the *breadth* of the fluid and varies with the square root of the *depth.*

4. It is established that there is in every navigable stream a certain velocity at which it will be more easy to *ascend* the river against the current than to *descend* with the current. Thus, if the current flow at the rate of one mile an hour in a stream four feet deep, it will be easier to *ascend* with a velocity of eight miles an hour on the wave, than to *descend* with the same velocity behind the wave.

5. That vessels may be propelled on the summit of waves at the rate of between 20 and 30 miles an hour. Trans. Brit. Assoc. & Lond. and Edin. Philos. Mag.

Communication of Vibrations through soil. By Capt. DENHAM. Capt. Denham ascertained that the vibrating effects of a passing laden rail road train in the open air extended laterally on the same level 1110 feet, (the substratum of the positions being the same,) whilst the vibration was quite exhausted at 100 feet when tested vertically from a tunnel.

The tunnel was through a stratum of sandstone rock: the rails laid in the open air on a substratum of 12 feet of marsh over sandstone rock. The method of testing was by mercury reflecting objects to a sextant. The experiments were made in the neighborhood of Liverpool.

Trans. Brit. Assoc., Lond. and Ed. Philos. Mag.

Progress of Practical and Theoretical Mechanics and Chemistry.

Cutting Veneers. Veneers used to be cut by the hand-saw; at present, the circular saw is, I believe, universally employed in England for this purpose, with the advantage not only of cheapness and expedition, but of a smaller waste of wood in saw dust, and of greater accuracy and precision in the thickness of the veneer—a quality essentially requisite to produce good work in the finished article.

In a large veneer-mill which I had an opportunity, through the kindness of one of our members, of visiting, there are five circular saws. Each consists of a strong, stiff, circular frame-work, of the shape of a plano-convex lens, or rather a low hollow cone, tapering gradually to the edge, from which projects a ring of soft steel a few inches broad, pierced with many holes. The saw is a plate, or rather a flat ring, of well-tempered steel, about twelve inches broad, pierced with as many holes as the former ring, and firmly secured to it by means of screws: a band over the axis of the saw communicates motion to it, by connecting it with the first mover, which is a steam engine. The wood to be cut is laid on the cross-bars of a frame, which are previously covered with glue, and remains in a horizontal position, loaded with heavy weights, till the glue has become dry. The frame, with the log, or *flitch*, as it is technically called, adhering to it, is then fixed sideways in a carriage which traverses backwards and forwards, the frame itself being likewise capable of motion at right angles to the run of the carriage, in order to project the log sufficiently to bring it within the action of the saw. The quantity of the latter motion is regulated by a screw, one turn of which throws forward the frame, and, consequently, the log, about $\frac{1}{10}$ of an inch. The saw being put in motion, the workman first turns the regulating screw more or less, according to the required thickness of the veneer; he then, by pulling a lever, throws the apparatus into gear, which gives motion to the carriage, and takes his seat by the inner, or con-

vex, side of the saw. As soon as the log comes up to the saw, he directs the head of the veneer into a curved frame, which it readily enters, on account of its flexibility, being so very thin, and then employs himself in holding in each hand a chip of wood obliquely against the teeth of the screw, in order to clear them of the particles of saw dust which otherwise would more or less clog up. In a minute or two the log has passed the saw, the motion of the carriage is reversed, and it is brought back to the point from which it first started. Being then thrown out of gear, the regulating screw is again turned, to project the log as much as the intended thickness of the next veneer; and then all those motions are repeated which I have already described. The usual thickness of a veneer is about $\frac{1}{12}$ of an inch; but some kinds of wood may be cut as thin as about $\frac{1}{16}$ of an inch. About half the wood is converted into saw dust.

Of the fine saws employed at these mills, the largest is eighteen feet in diameter, and makes thirty revolutions in a minute. Three are each ten feet in diameter, with a speed of about sixty revolutions in a minute; the small saw is six feet in diameter, with a speed of eighty revolutions in a minute, which is sometimes increased to one hundred, or even one hundred and twenty revolutions. The teeth of the saws are nearly a quarter of an inch deep. A saw lasts about a year; for the first six months it is employed in coarse work, and afterwards, till worn out, in fine work.

The veneer is necessarily split, for an inch or two at its head, in getting it on the curved frame; and as it is likewise liable to split in drying, a thin strip of linen is glued along the two cross edges of each veneer, which prevents this accident: the holes, at least those of an inch or more across, are also covered in the same manner.

The general method of laying down veneers is very simple, although to do this well and correctly, requires, as every thing else does, practice, attention, and patience. The under side of the veneer, if previously smooth, must be scored by means of a toothing-plane; but if cut by a circular saw, it generally acquires a sufficient tooth by that operation. The surface to be veneered is covered over with strong glue, and before it chills or gelatinizes, the veneer, previously prepared and cut to the shape required, is laid down upon it, care being taken in doing so, to enclose as little air as possible. When it has been pressed down to its proper bearing in every part, the compound piece is enclosed between two hot boards, secured at the edges by thumb screws, or, which is still better, is put into a press between two hot plates, where it remains till perfectly dry.

The next process is to give a smooth surface to the veneer, which is effected by first filling up any holes by plugs of the same kind of wood cut to fit them, or by making a paste of fine saw dust and glue, and pressing it into the holes by hand, and then by the successive use of small planes, scrapers, files, glass-paper, Dutch rushes, and fish skin. Lastly, a varnish is added, which has the effect of bringing up the colour and lustre of the wood, and protecting it from the action of the air. If the colour of the wood is itself unexceptionable, the varnish should be as colourless as possible; but if a little mellowness or warmth is required, a varnish coloured accordingly must be applied. The so called, French varnish, has within the last few years almost entirely superseded the oil varnishes, as being more quickly applied, possessing more lustre and hardness, being less liable to be injured by any common liquid spilled upon it, and not requiring to be renewed or refreshed except at long intervals. It is made by dissolving lac in spirits of wine, and then shaking it up with olive-oil to the consistence

of an emulsion, in which state it must be used. It is fixed on the surface of the wood by means of a linen rubber, applied with a circular or spiral motion. Varley in Trans. Lond. Society Arts.

Lighting and Ventilation. Questions proposed by the Committee of the Athenæum to Mr. Faraday, on Lighting and Ventilation, with the answers. Originally printed February 14th, 1831.

[We re-print the present article, by permission, from a document which has been circulated among the members of the Athenæum.]

Q. What is the ratio of light of an oil and gas burner?

A. In an experiment made at the Athenæum, with an excellent Argand oil lamp, regulated by Mr. Hancock, and compared with a 15-hole gas burner, the light of the gas was to that of the oil as 21 to 13.

Q. What is the ratio of heat?

A. In experiments made to determine the heat evolved for *equal quantity of light* from oil and gas burning brightly from Argand burners, the heat from the oil being 2, that from the gas was nearly 3.

Q. Is either sulphurous or sulphuric acid formed by the combustion of coal gas in the ordinary way?

A. A little sulphurous or sulphuric acid is generally formed from the combustion of coal gas. If well purified gas be used, this product is rarely sensible: it is less sensible as sulphuric than as sulphurous acid. Upon closely questioning persons who have declared that they smelt sulphur from gas, I have usually found they meant something else—generally the oppressive heat, or the dry sensation, or the smell of a little gas unburnt, none of which have any thing to do with the sulphur-product from gas.

Q. From a gas light, properly regulated, is gas respired?

A. I do not believe that any gas escapes unburnt from a gas light well regulated. It is far more likely that oil vapour should escape unconsumed from an oil burner, than gas from a gas burner.

Q. Will an oil or gas light soonest soil the ceiling of a room?

A. Neither oil nor gas ought to soil, or will soil, the ceiling of a room, if well regulated. Either will do so when badly regulated. I think of the two, oil is most likely to do so; because of the changes which take place in the wick, in the temperature of the oil, &c., during burning, and which do not occur with a gas lamp properly regulated by a governor.

Q. What effect will the heat evolved have on the temperature of a room?

A. This effect depends upon so many circumstances, as the size and tightness of the room, the proportion of light, &c. &c., that it can only be deduced from a series of observations.

Q. What are the comparative effects of oil and gas lights on the quality of the air, light for light?

A. It is exceedingly difficult to ascertain, and if ascertained, to describe correctly the effects of lights on air so as to convey a just opinion of their influence; thus, with regard to their greatest effect, which is the power of heating, it is of advantage and desirable up to a certain point, and above that point is unpleasant and disagreeable: but that point depends upon many other things as well as the lights, and, what is still more important, differs for different persons, so that it becomes in that respect impossible to please all. Gas light will heat air faster than oil light; it therefore at first does good quicker, and afterwards does harm quicker, than oil. As to the proportionate deterioration of air by the oxygen abstracted, I think it probable that gas would, *light for light*, have the greatest effect; but I do not believe that effect would be sensible in either case. As to the deterioration of air

by the sulphurous acid and unburnt gas thrown into the room, I think little of it in the present case. I think that to be rather a popular error, caused by persons ascribing effects which they feel but cannot discriminate, to the first single cause which occurs to them, thinking of quality only and forgetting quantity.

Q. What are the comparative qualities of the light from oil and gas?

A. When the oil was burning in its best manner, still it gave a much yellower flame than the gas; the whiteness of the gas flame is a necessary consequence of its higher temperature.

Q. Taking all the circumstances into consideration, what, in your opinion, is the cause of the oppressive feeling complained of in certain rooms in the Athenæum?

A. In my opinion the principal cause of complaint is of the following nature: A house has been built, and every endeavor made to render floors, ceilings, windows, walls, and doors, tight and close; the rooms in it are well warmed during the day, and, having been brought to such a temperature and state that the first person who enters is fully satisfied; from fifty to two hundred persons are introduced, evolving both heat and effluvia; a number of powerful burners are put into and continue in action; and when the injurious agency of these causes has continued for one, two, or three hours, complaints are made that the heat is oppressive, or the odour unpleasant. Things are arranged so as to produce a perfect effect under one set of circumstances, and then, changing the circumstances, the effect is expected to remain the same, though it must of necessity be different. The large room and the library are made quite warm enough by daylight, when there are only a few persons there: then they are lighted, many persons enter, and they must of course very soon expect an oppressive sensation. I have no hesitation in believing that the cause of these complaints might be removed by extending and adjusting the system of ventilation in those rooms.

Q. Why has oil been displaced by gas in the public rooms of the Royal Institution?

A. Oil has been displaced by oil gas, in the first place, because of the economy of the latter; then because of its superior cleanliness, and its facile management. Much harm was done to our seats in the lecture-room during the use of oil lamps. We still burn oil in table-lamps in our library, on other evenings than the Fridays, because we require less light on those occasions.

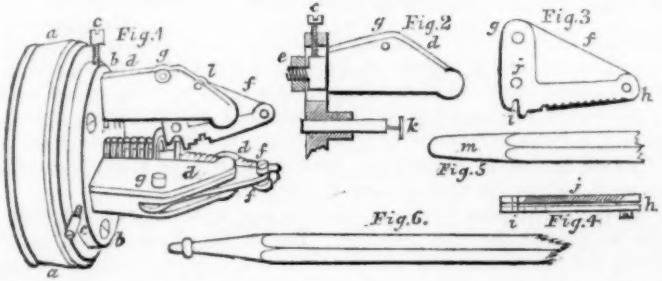
Athenæum, London, 26th April, 1836. Rep. Pat. Invent.

Franklin's machine for making Tips for Umbrellas. The ribs or stretchers of umbrellas are terminated below in balls or some other ornament which are *tips*. These tips are sometimes of bone or of metal, and sometimes the ribs are *self-tipped;* that is, the tip is made by rounding the end of the whalebone itself into the required figure. Considerable difficulty has been experienced in making these tips with sufficient precision, as they must of course be made in some cheap and expeditious manner. The usual method was by rough-filing them into shape, and then giving the requisite degree of smoothness by means of glass-paper. Mr. Franklin, perceiving the tediousness of this mode, and yet knowing that whalebone, from its fibrous and elastic structure, requires to be brought into shape rather by filing and scraping than turning, which would be liable to tear up the fibres, has devised a tool possessing the properties of the file and scraper combined, and at the same time working with great speed.

Mr. Franklin obviates the necessity of fixing the whalebone in the chuck,

by holding it in a hand-vice and presenting it between three compound cutters that project from the face of a chuck, and revolve with the full speed of the lathe, by which the determined form is almost instantaneously given to it.

In fig. 1 *a a* is the chuck which screws on to the nose of a mandril: it has a seat turned in it to receive the circular plate *b b*, and a cavity deep enough for screw-nuts at the back of the plate. In this plate are three radial openings with adjusting-screws *c c* at their ends, in which are fitted the three forked frames *d d d*, which are fixed by screw-nuts, one of which



e is shown in fig. 2. These frames hold the compound cutters *f f f* by the screws at *g g*, on which they turn as joints. Fig. 3, shows a side view of one pair of cutters, and fig. 4, a front view of their cutting edges. They are made of thin steel: the triangular plate *f* is filed along the edge *h i* to the exact form of the tip, and is set to a sharp cutting edge; on this is placed the second plate *j*, having collets interposed to keep them a little asunder, as shown in fig. 4. This plate is at first formed so as to correspond perfectly with the under one; it is then filed into a waved edge, almost as if making a saw: these small notches are inclined, as shown in fig. 4, in order to make their cutting edges meet the whalebone. The three pairs of these cutters are made exactly alike, and the holes *g*, by which they are jointed in the frames *d*, are also quite alike. The cutters so prepared are put into their frames *d*, and these are slightly bound in their places by the nuts *e*; they are then placed exactly at equal distances from the centre by the adjusting-screws *c c*, and then the nuts *e* are bound quite fast to fix them. It is requisite for these cutters of themselves to keep open enough to receive the whalebone; and it is also requisite for them to close exactly alike on the whalebone when the workman presses it in. To press them outwards or open, a spiral spring is placed on a neck projecting from the centre of the plate *b b*; and to make them open or close equally together, a poppet *k* slides in the central neck, as shown in fig. 2: this has a thin circular head *k*, and the cutters have exactly similar notches as at *i*, fig. 3, into which this head enters, and thereby causes them to move simultaneously. The cutters would fly outwards, poppet and all, if there were not a stop; but, as they can only move together, a stop to one cutter is enough—the screw *l*, fig. 1, is that stop: the back of the cutter *f* comes against it when they are all open enough. *m*, fig. 5, represents the end of a whalebone previously rounded, ready to be thrust in between the cutters described, whilst they are in rapid rotation: the waved cutters come first in contact with the whalebone, and cut through the fibres without tearing them up; the clear

cutters follow, and scrape off the ridges as fast as they are made by the waved cutters. This operation, being thus divided between two cutters, prevents the breaking up of the fibre. Fig. 6, shows the form given to the tip by these cutters. The cutters are never stopped to change the whalebone, but are kept constantly revolving, and the tips are formed almost as fast as the workman can press them in and take them out. Experience soon teaches him to give the pressure at which the cutters will act best on the material, which comes from this tool smooth enough to be varnished, or to be polished with oil and charcoal dust on leather. For this purpose the whalebone is turned quickly round with one hand, being at the same time supported on the thigh, whilst the other holds the leather round the tip to polish it.

Trans. Lond. Soc. Arts.

Howlett's Crayons for Drawing on Glass. Mr. Howlett's perspective tracing-glass consists of a plate of clear glass fixed in a frame, and set upright on a tripod stand, so as to bring it on a level with the eye of the artist. From the top of the tripod projects horizontally a light frame, with a hole at the end, for the purpose of supporting in a vertical position a pin, at the top of which is a small perforation, through which the artist looks while he traces on the glass the objects seen through it.

So far the instrument does not differ in any material respect from those usually employed for this purpose. But as the glass is not capable of receiving the traces made by the pencil, it is necessary to cover the surface of the glass with some substance, at the same time as transparent as possible, and capable of being marked by a pencil. These conditions, however, have not hitherto been found to be reconcilable: the most transparent paper that can be made is not capable of allowing distant objects to be seen through it with sufficient distinctness, and glass itself, though unexceptionable with regard to tranparency, will not retain traces from a black lead pencil, or from any other of the materials usually employed in sketching.

The way in which Mr. Howlett has solved this problem, is by the invention of crayons capable of bearing a fine point, and of leaving traces on the surface of glass. In the use, therefore, of this instrument, the objects are delineated with the crayon on the surface of the glass, and afterwards a piece of paper is laid over the drawing, and is secured by its four corners to prevent it from slipping; the glass with the attached paper is then held up to the light, and the objects already drawn on the glass are traced on the paper with a common pencil. If the paper, instead of being laid on the drawing, is placed on the opposite surface of the glass, the copy will be made in a reversed position, and is thus immediately adapted to the use of the engraver: or the tracing on the glass may be transferred to the paper, by laying the paper over the tracing, and rubbing them together with an ivory handled knife.

If the tracing-paper employed is thick or opaque, so that the lines on the glass are only seen indistinctly through it, a great degree of blackness may be given to them, by dusting the surface of the glass over with dry lamp-black, and then rubbing it off with a soft camel-hair brush, very lightly applied; the traces made by the crayon being somewhat adhesive, the lamp-black will be fixed on them by the action of the brush, while it is swept off from the rest of the surface.

The crayons are made of three degrees of hardness, to suit any climate, and are not acted on by water, either fresh or salt. Asphaltum and yellow bees-wax, in equal proportions, are melted together, and then lamp-black, just sufficient to give it colour, stirred in; the mixture is then cast into

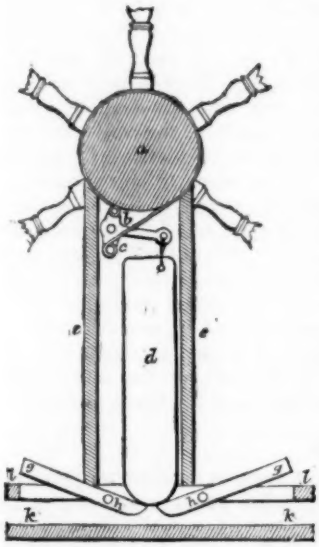
sticks, and forms a crayon suitable for a temperate degree of heat; but, for very hot weather, the hardest kind of heelball, lowered with a little tallow, answers admirably.

The glass plate, previous to drawing it, should be rubbed well with a leather, in order to free it from moisture or dirt, and the artist, while making the drawing, should wear a finger-stall.

It is sometimes difficult to bring the crayon to a fine point with a common penknife; for if the edge of this latter is set to the shape of a very fine wedge, it will slip through the crayon, as, on the other hand, a blunt wedge will break off the point before it has been cut sufficiently fine; but if the knife is set chisel-shaped, the oblique surface being applied next to the crayon, shavings of extreme tenuity may be taken off, and a very fine point will be the result. Trans. Soc. Arts, Lond.

Pearce's Stopping for a Steering-Wheel. The pressure of the sea on the rudder is sometimes so strong, as to overpower the man or men at the steering-wheel; the consequence is, that the men are knocked down, and often seriously hurt, and the safety of the ship itself may be endangered by the rudder suddenly flying round. Mr. Pearce has done for the steering-wheel what has long ago been done for the crane and other similiar machines; that is, he has attached a brake to it, capable, by its friction, of so far controlling the pressure of the rudder, as to enable the helmsman to retain the command of it.

The annexed figure presents a section immediately behind the wheel, and before its post, the spectator looking a head. The axis of the wheel *a* is nearly surrounded by a copper band, the extremities of which, *b* and *c*, are attached to the short arms of a T-shaped lever turning on a centre between *b* and *c*, and from the longer arm of which is suspended the leaden weight *d*. The end *c* of the copper band is split, and its halves pass on each side of the T-shaped lever. The whole of this apparatus is contained in a case formed in front of the post, the sides of the case *e e* being shown in section. It will be seen that the effect of the weight *d*, acting through the instrumentality of the T-shaped lever, is to tighten the copper band round the axis of the wheel, and thus, if not to supersede, at least very much to relieve, the labour of the steersman in holding the wheel during rough weather. When any alteration in the ship's course is required, the wheel may be set free by pressing the foot on either of the levers *g g*, which turn on the centres *h h*, raise the weight *d*, and thus relieve its pressure on the copper band. The levers *g g*, may, when required, be kept permanently down, in which case they form a part of the small floor or platform *l l*, raised a few inches above the surface of the deck *k k*. Ibid.



Higgins Oblique Candlestick. In the annexed figure *a a* is the tube which contains the candle, resting on the spiral spring: it is about fourteen inches long, rather more than an inch in diameter, and is inclined about thirty degrees from a vertical line. The cap or nozzle *a b* slips on with a bayonet joint, and has a hole at the end about five-eighths of an inch in diameter, through which the wick protrudes. A small lip *c* projects from the nozzle, to catch any trifling overflow of tallow which may possibly happen when the candle is first lighted. The base of the candlestick *d*, and the curved support *e* to which the extinguisher is attached, do not require description. It is obvious that the spiral spring must be of such a length as to keep the candle close up to the cap *b* till it it entirely consumed.

From several experiments it appears that a candle placed in this stick is burned more perfectly, and with less waste and guttering, the more it is blown about by the wind, provided the draft is not so violent as to extinguish it. Ibid.

Indian Sword-Blades. The thanks of the Society were voted to Capt. Bagnold, R. N., of Blackheath Villa, Saxmundham, for the following account of the manufacture and tempering of Sword Blades in the province of Cutch, from information communicated to him by his brother, Lieut. Colonel Bagnold, late President of the Regency in Cutch. These swords are celebrated throughout India for their peculiar strength and edge, and are thus made:—An inch bar of fine Swedish or English steel is forged out into plates seven inches long, one inch broad, and one-sixth of a inch thick. Similar bars of fine, soft iron are prepared in the same manner. These are smeared with a paste of borax dissolved in water, and laid in piles of twelve—nine of steel to three of iron, or three to one alternately: each pile is wrapped round with a rag thickly plastered with mud made of a loamy earth; then heated, welded, and drawn out to a bar one inch and one-eighth broad, and one-third of an inch thick: this is bent zig-zag three or four times; is again welded and drawn out to half an inch thick; and, during the heat, borax is frequently dropped on the metal while in the fire. Two of these bars are next welded into one, and when about twelve or fourteen inches long, it is bent into the form of a loop or staple; in the middle of this a piece of fine-grained file is inserted, of the same width, and nearly as thick: all is then welded together, and the blade is formed.

Tempering.

An earthen pot twelve inches wide and six deep, is notched on the edges (the notches being opposite each other), with a file about a quarter of an inch deep, is then filled nearly up to the notches with water, and oil is then poured on the surface. The blade, being heated equally to a light red, is removed from the fire, and the point, entered in the notch on the edge, is passed to the opposite one, keeping the edge from a quarter to half an inch in the oil: it is drawn backwards and forwards rather slowly till the hissing ceases and the rest of the blade above the fluid has become black; a jug of water without oil is then poured along the blade from heel to point. In order to take out the warp produced by tempering, the blade, when nearly cold, is

passed over the fire three or four times; then being brought to the anvil, is set straight by striking it regularly, but moderately, with a hammer; by this means the Damascus-curved blade may be brought nearly straight. Blades made in this way in my brother's presence, when he was President of the regency in Cutch, were proved, previous to grinding, by striking at stones, ram-rods, musket barrels, and even wheel-tires, without injury to the edge. Ibid.

Silk Worms. To meet the objections on the score of climate, I would suggest, first, that we ought to breed silk worms in hot-houses throughout the year; and, secondly, that the Pavonia Moths of Europe and other countries, as well as Atlas Moths of Asia, should be reared in like manner. It has already been remarked, that several crops are obtained in the east within the year; and why may we not also expect in England several, by means of breeding the worms in hot-houses. In India the longest period for a generation of silk worms appears to be forty days: even allowing fifty days in England for a generation, we may then expect seven crops of silk. If we only obtain four, that is double the number produced in Italy, where they annually rear but two. I need now scarcely add that four crops will repay the speculator for rearing silk. To reduce, however, the expenditure as much as possible, I would recommend him to feed the silk worms with lettuce instead of mulberry leaves; first, as there is less expense in the cultivation; secondly, as the lettuce can be grown cheaply in cucumber frames during the winter months; and, lastly, as the quality of the silk does not depend so much on the *quality* of the *leaf* as it does on the *degree* of temperature in which the worm is reared, I would strenuously recommend the lettuce. Should the food of the mulberry tree, however, be preferred to the lettuce, we can still adopt the discovery of Ludovico Bellarde, of Turin. His plan consisted in giving the worms the pulverized leaves of the mulbery trees slightly moistened with water: the leaves were gathered in the previous summer, dried in the sun, reduced to powder, and then stowed away in jars for the winter food, or till the tree was in full foliage. Repeated experiments made by Bellarde prove that the worm preferred this kind of food to any other, as they devour it with the greatest avidity. To reduce still further the expenditure, old men, women, and children might be employed in feeding the worms, as is the case at present in India: indeed, might not the poor in the work-houses be rendered available, thus affording them amusement and profit? Ibid.

Dr. Church's Steam-Coach. We have much pleasure in stating that Dr. Church has at length completely and satisfactorily accomplished the construction of a steam carriage, in every way suited to run on ordinary roads.

The external appearance of the carriage is made exactly to resemble a stage-coach, and is about the same dimensions. It consists of a frame work with a casing enclosing the boiler and engines; the furnace, fuel-box, water chamber, and condenser, all of which hang upon springs, supported by the running wheels, require no auxiliary tender.

The casing is formed and painted like an ordinary stage-coach, the conductor sits, for the purpose of steering, in the place of a coachman, on the box in front; the engineer who attends the fire and the machinery, and has command of the steam, stands also in front, in an open compartment, below the conductor.

There are seats for the persons on the roof before and behind, as in other stage-coaches; but as this carriage is intended merely to be the loco-

motive engine for impelling a train of carriages connected to it, the seats upon this are to be considered as of an inferior class.

Some of the most important features of the locomotive carriage as now completed, viz. the peculiar construction of the boiler and arrangement of the working parts of the machinery, form portions of the subject of a patent granted to Dr. Church, on the 16th March, 1835; the specification of which, embracing other matters, is too elaborate for insertion in our present number, but will most probably appear in our next.

As several partially successful, but, in our opinion, very unsatisfactory attempts have been made by other persons, to impel carriages on ordinary roads by steam power, we consider it necessary to point out some of the peculiarities in Dr. Church's present carriage, which we consider to be its striking features of advantages.—Firstly, though the engines work at high pressure, the eduction steam is so effectually condensed after passing from the working cylinder, that no visible portion of it escapes into the air, but the whole is converted into water, and re-conducted into the boiler in a heated state. Secondly, the flues are so constructed and arranged, that no smoke is allowed to escape from the chimney; and the consequences of these two novel features, as regards locomove engines running on ordinary roads, are very important, viz. that neither is there any perceptible noise arising from the discharge of steam, or any offensive effluvia emitted from the combustion, so that the carriage proceeds along the road without, in the slightest degree, attracting the attention of horses which may pass it.

We have only space to say further, that the Birmingham and London Steam-carriage Company, with whom the Doctor is connected in this invention, are perfectly satisfied with the carriage as now completed; and though alterations and slight improvements may and will necessarily be adopted in the future exercise of the plans, yet they deem the present carriage to be so fully effective and satisfactory, that they have advertised for a practical engineer to superintend the erection of a sufficient number of these carriages at their works, exactly according with the model produced.

We understand it to be the intention of the company to establish three stations between London and Birmingham for their trains of carriages to halt at, and to supply a fresh locomotive engine at each station, in order that the engines, after running about twenty-six miles, may be severally examined, and such little matters as cleaning, oiling, and adjusting parts attended to: which arrangement will avoid subjecting passengers to the inconvenience of delay, and tend greatly to prevent accidents.

We have only to add, that having witnessed the manner in which this carriage performs its duty on the public road, we have no hesitation in saying that we are now satisfied that steam may be safely, and, we believe, economically, employed, in connection with Dr. Church's improved machinery, as an effective substitute for horses, in the ordinary transit of stage-coach passengers on all the turnpike roads in the kingdom.

Lond. Jour. of Arts, Aug.

Progress of Civil Engineering.

Principles of Railway Transit, as they regard the force of traction, expense, and speed. By JOHN HERAPATH, Esq.

Force of Traction.

If t denote the force of traction of a ton on a level, and z the angle of inclination of any plane,

$$t \cos z \pm \sin z,$$

is obviously the force of traction in ascending or descending the plane, the plus sign being used for ascending and the minus for descending. And because in all practicable railways z is very small, which gives $\cos z = 1$, and t by experiment about $\frac{1}{240}$, the force of traction is as

$$1 \pm \frac{h}{22} \text{ very nearly.....(1)}$$

in which unity is the force of traction on a level, and h the height in feet per mile of the inclined plane.

Expense of Transit.

Since this force of traction is the same for all velocities, it follows that, the load being the same, and the temperature of steam the same, the quantity of steam consumed, supposing it to follow in a column, would be the same for a given distance, whatever be the velocity; and as the distance run, that is, as the velocity, for a given time. Consequently, the expense, which I presume must be proportional to the amount of such steam so consumed, is the same for a given distance, at whatever velocity run. Therefore if l be the load, d the distance, and e the expense.

$$e \propto l \times d.$$

For two engines would be required under the same circumstances to tow a double load, three a triple load, &c.; and hence it is reasonable to infer, that the expense of the same engine exerting a double, triple, &c. force, would not sensibly differ, if at all, from the same rule. Consequently, if for l we put (1) multiplied by $a\ l$,

$$e = (1 \times \frac{h}{22})\ a\ l\ d....(2)$$

where a is a constant to be determined from experience. It is hardly fair to apply the theorem in descending planes, particularly unless the descent is less than 22 feet per mile, owing in the first instance to the waste of steam by turning it off, and in the second to the breaks being generally used to check the descending velocity.*

Now, according to the average experience on the Liverpool and Manchester Railway, the expense of transit, Mr. Dixon, the Company's intelligent engineer, informed me, is about a half-penny per ton per mile, though there are other railways, I believe, in which it does not exceed half of this sum, or a farthing per ton per mile. Hence l being the load in tons, and d the distance in miles, we have in pence,

$$e = (1 + \frac{h}{22})\frac{l\,d}{2} ....(3)$$

Under any other circumstances the 2 must be changed into the divisor of a penny, which the cost of transport happens to be.

Velocity of Transit.

If we suppose a piston one-half the area of another, it must evidently travel with twice the velocity to consume the same quantity of steam at the same elasticity and temperature, and its force will, of course, be just one-half. Therefore a half load, under such a circumstance, would be driven with a double velocity. In the same way a third and a fourth of a

* If $h = -22$ feet, it is obvious that $t = 0$, or the friction of 240th would be in equilibrium with gravity without any assisting power. If h is greater than 22, there will be an accelerating force derived from the weight of the body, which corresponds to the negative value of t. B.

load would be driven with three or four times the velocity; and, generally, other things being alike, the velocity would be inversely as the load, the area of the piston varying as the load.

But supposing the piston and fire to remain the same, what would be the velocity of a double, triple, &c. load? This is a question which I am not aware has ever been satisfactorily answered, physically or experimentally. Indeed, on the received doctrine of airs, I do not think it admits of an answer. I shall endeavour to solve the problem physically, on the only reasonable principle I can imagine, and on laws of aeriform bodies published and constated with experiment by me fourteen years since in the Annals of Philosophy. Let it be distinctly understood, that not being quite certain of the principle alluded to, I do not offer it as a demonstrated solution; but I should be glad to see it brought to the test of experiment, and whenever it shall be, I do not expect it will be found much in error. If so, it will have the merit of bringing within the grasp of physical science one of the most important points in the action of the steam engine.

The principal referred to is this:—That the number of steam particles emitted every moment, drawn into the temperature of the steam, is always proportional to the heat simultaneously communicated by the fire to the water.

If, therefore, the heat communicated be uniform, and N denote the number of particles momentarily emitted, and T the true temperature of them,

$$N\,T \text{ is a constant quantity.}$$

But if E be the elasticity of the steam, and n the number of its particles contained in a given space,

$$E \propto n\,T^2,$$

by Prop. 8, Annals for May, 1821, p. 345. And if V be the velocity of the piston, n V is evidently as the number of particles of steam momentarily carried off or emitted. Therefore,

n V $\propto$ N, and T n V $\propto$ N T a constant. Hence,

$$E \propto n\,T^2 \propto \frac{1}{TV} \times T^2 \propto \frac{T}{V} \propto \frac{\sqrt{F+448}}{V},$$

(according to Cor. 2, Prop. 1, p. 98, Annals for Aug. 1821) F being the Fahr. temperature. But E, the elasticity will be as the load or force of traction, and V as the velocity of the engine. Consequently,

$$\left(1+\frac{h}{22}\right) l\,V \propto \sqrt{F+448} \ldots\ldots (4)$$

Moreover, because when the elasticity of steam, at its proper tension, is tripled, the right hand member of the equation will increase only about 5 per cent. we may consider this member constant for all practical purposes; and hence the velocity of transit, other things alike, will be inversely as the load and force of traction.

We are now in possession of three rules of comparision, as simple and correct as, I believe, it is possible, in the present state of our knowledge, to make them.

First, the force of traction on any plane inclining with the horizon h feet per mile is,

$$9\left(1+\frac{h}{22}\right) \text{ lbs. up, or } 9\left(1+\frac{h}{22}\right) \text{lbs. down}$$

per ton, allowing the draught per ton on a level to be 9 lbs.

Secondly, the expense of transit per ton per mile is, in pence,

$$\tfrac{1}{2}\left(1+\frac{h}{22}\right) \text{ up, or } \tfrac{1}{2}\left(1-\frac{h}{22}\right) \text{ down,}$$

suppposing the steam at all times to act as the motive or retarding power.

Thirdly, the speed, if it be 30 miles per hour on a level, is

$$\frac{30}{1+\frac{h}{22}}$$

We can hardly apply this formula to descents, unless they are very small; for if the descent was 22 feet per mile, it would make the velocity appear to be infinite in consequence of gravity doing all the work, and the object to be propelled amounting, therefore, to nothing.

For the more readily examining the capabilities and economy of any line, I have computed the subjoined table. The last column was computed by multiplying the third with 30, and as the succeeding decimals were not taken into account, it may not be quite correct in the decimal figure; but it is quite near enough for any practical purpose.

Elevation per mile in feet.	Force of Traction, in pounds per ton.	Parts of a load.	Expense per ton per mile in pence.	Velocity per hour in miles.
0	9.00	1.00	.500	30.0
2	9.82	.92	.545	27.6
4	10.64	.85	.591	25.5
6	11.45	.79	.636	23.7
8	12.27	.73	.682	21.9
10	13.09	.69	.727	20.7
12	13.91	.65	.773	19.5
14	14.73	.61	.818	18.3
16	15.55	.58	.864	17.4
18	16.36	.55	.909	16.5
20	17.18	.52	.955	15.6
22	18.00	.50	1.000	15.0
24	18.82	.48	1.045	14.4
26	19.64	.46	1.091	13.8
28	20.45	.44	1.136	13.2
30	21.27	.42	1.182	12.6
32	22.09	.41	1.227	12.3
34	22.91	.39	1.273	11.7
36	23.73	.38	1.318	11.4
38	24.55	.37	1.364	11.1
40	25.36	.35	1.409	10.5
45	27.41	.33	1.523	9.9
50	29.45	.31	1.636	9.3
55	31.50	.29	1.750	8.7
60	33.55	.27	1.862	7.1

JOHN HERAPATH.

Kensington, June, 1835.

Lond. Mech. Mag.

[Extracts from a communication to the London Mechanics' Magazine.]

Daglish's Prize Rails and Pedestals. I herewith send you drawings of my parallel rail and joint and intermediate pedestals, with the mode of fastening them to the stone blocks or sleepers, and also my method of keying the rails into their respective pedestal; for all which I obtained the premium lately offered by the London and Birmingham Railway Directors, with the exception of the mode of fastening the pedestals to the stone blocks, which the Committee of reference are said to have thought inferior to the lewis-pin of Mr. Swinburn, to whom the Directors accordingly awarded a third of the premium. I have also added sketches of certain modifications of my rail and pedestals, which it might be advisable to adopt under particular circumstances, and in some peculiar localities.

Fig. 1.

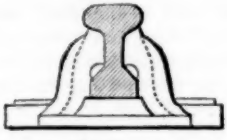


Fig. 2.

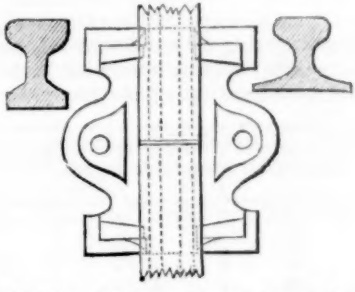


Fig. 3.

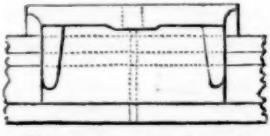


Fig. 1, is an end-section of the parallel rail and *joint*-pedestal (the pedestal where two ends of different lengths of rail meet); showing also the mode of keying the rail by cotter bolts. Fig. 2, is a plan of the above; and Fig. 3, a side section. The weight 50lbs. per yard. The stone blocks are from 10 to 12 inches thick, and contain from 4 to 5 cubic feet; the cotter bolts are $\frac{3}{4}$ inch round.

Fig. 4.

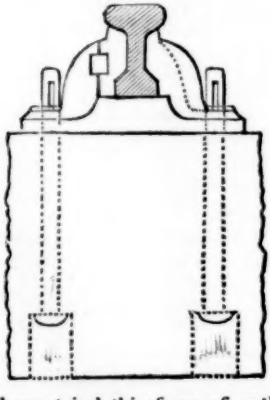
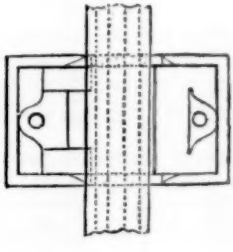


Fig. 5.



I have tried this form of rail against ten other forms of rail of the like weight per yard or thereabouts, not only by actually running heavy locomotive engines over them, but by means of the steelyard and lever, and have always found that it will carry more weight than any other with the

least deflection. The simplicity of its construction, too, is greatly in favor of its being soundly made.

Fig. 4, is an end section of the same kind of rail, with the *intermediate* pedestals; and Fig. 5, plan of the same.

The joint-pedestal is made of nearly twice the bearing of the intermediate ones, in order that the ends may be the more effectually secured.

Mr. Barlow made his experiments with my form of rail, which he pronounces to be by far the best, and recommends the mode which I proposed of fixing the pedestal to the stone block, *and not Mr. Swinburn's.*

Indeed, to all who are practically conversant with railways, it must seem as inexplicable as surprising, that the lewis-pin method should have been thought worthy of favorable mention at all, far less of being honoured with a premium. Were such a mode of fastening adopted (as it most assuredly never will), it would not be long before the concussions from the passage of heavy locomotive engines, at great velocities, would infallibly split the stone to the depth of the lewis.

The mode of fastening practised by me, and approved of by Mr. Barlow, consists, as will be partly seen from inspection of the figures, in inserting plain cotter bolts through the stone, and countersinking the hole up from the bottom for the space of an inch and a half or two inches, so as to permit the point of the bolt to drop below the base of the pedestal. I first tried screw-bolts, but was obliged to abandon them in consequence of the nuts getting, through corrosion, so fast to the bolts as to twist the bolt-ends off before they would unscrew. Fifteen years' experience has now satisfied me that the plain cotter bolt is the only one that will answer.

Mr. Barlow, speaks of this method of fastening as if it were the suggestion of Mr. Vignoles. But how he should have fallen into such a mistake, I cannot comprehend; for it was not only fully shown in the models I sent in to the London and Birmingham Railway Directors, but the advantages of it were particularly dwelt upon in the letter which accompanied them. To place this beyond all doubt, I will here repeat those passages of my letter which relate to this point:—

"The pedestal for the joint I would particularly recommend to be fastened to the sleeper with cotter bolts; I would also prefer fastening all the intermediate ones in like manner, though they would answer to be well nailed in the usual way, but much better with cotter bolts, as you then derive the greatest effect from the parallel rail, by keeping every pedestal firmly down. If only nailed, this may prevent the intermediate pedestals becoming fulcrums, in which case the fibres of the upper surface of the rail are not called into tension in the same ratio with those on the under side of the rail, immediately between the pedestals, while the locomotive or any other heavy carriages are passing along the line."

Again:—

"I prefer the mode of fastening the pedestals with cotter bolts as by far the most effectual for general use; if even they have to be fastened with smaller bolts (say $\frac{5}{8}$ths diameter), more especially when they can be thus secured at as cheap a rate as if fastened by nails. The holes for the small bolts can be drilled through the stone sleepers for less than the large holes necessary to receive the wooden plugs; and the small bolt and cotter will only cost a trifle more than the nail and wood plugs, as both the bolts and cotters can be made by a machine for that purpose."

Mr. Vignoles, though he certainly did not suggest the use of the cotter bolt, has done me the honour to cause it to be adopted in the construction of the Dublin and Kingstown Railway, instead of the nails or spikes commonly used.

Mr. Barlow makes some very forcible observations on the importance of exact fitting and fastening; but to show you that all practical men have not been so indifferent to these matters as Mr. Barlow imagines, I will, with your leave, make another short extract from my letter to the London and Birmingham Railway Directors, which has an immediate bearing upon this part of the subject:—

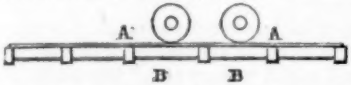
"I am quite sure a velocity of from 50 to 60 miles per hour may be obtained upon a well-constructed railway, with greater safety than one of 20 miles, upon any of the present lines yet in operation; not only from their having too light a rail and ill-constructed pedestal, but from the mode of fixing them, *especially at the joints*, which is the great cause of so much deflection and sudden action, both vertically and horizontally—so that it is not in the power of man to make a locomotive engine to stand the action they are subject to long together.

"I have frequently stated to companies, that every public railway ought to be laid down as accurate and as firm as it is possible for hands to do them; and, when that is done, to put a steam engine upon them to plane the surface, the same as we do our slide rails."

I must also use the freedom to observe that, correct as Mr. Barlow's views are, of the importance of executing all railways in the best possible style of workmanship, he shows in nearly all that regards the details, great want of practical knowledge. Speaking of keying the rails to the pedestals, he says, that "if the rails and chairs be not permanently fixed to each other by direct means, it ought not to be attempted by indirect means, viz. by cotter keys or wedges, for either these will hold the rail to the chair, or they will not; if they do hold fast, they produce all the mischief which permanent fixing would occasion; and if they draw, then they do no good, although they may still do mischief." Now, if the Professor ever had an opportunity of carefully watching for a summer's day the passing of heavy steam carriages and long trains of other heavy carriages over a railway, he would never have ventured such a statement. He would have witnessed, that it is scarcely in the power of man to fasten the rails permanently to the pedestals. Aware of the impracticability of doing so, I do not allow the D key proposed by me (see fig. 1), when used to key the rail to the *joint*-pedestal, to be driven with more than a single-hand hammer; and also stop it at its place when driven, the key being here merely intended to act as a steadiment to the rail. For before a locomotive engine or heavy train has passed twice over the rails, the whole of the keys give or yield of necessity in such a manner as to allow the rails to expand or contract more than what they really do, or are subject to, from the differences of temperature to which they are exposed. With respect, however, to the *intermediate* pedestals of the five-yard rails, the more soundly they are keyed to the rail the better, so as not to injure the pedestal by over-driving the key, as there is more latitude in the holes through the base of the pedestals where the bolts pass, than would compensate for treble the expansion and contraction the rails are subject to. Besides, each of the holes drilled through the stone blocks upon which the pedestals rest, is drilled $\frac{1}{8}$th of an inch larger than the diameter of the bolts, and the pedestals can never be so hard cottered down to the surface of the stone but what they will give a little. All difficulties on this head I got completely over several years back, in both wrought and cast-iron railways which have been laid under my direction. I could refer Mr. Barlow to several miles of railway which have been worked for years, and remain at

present perfectly firm without the least distortion, either vertically or horizontally.

Again: notwithstanding Mr. Barlow has actually proved by experiment that the parallel rail is superior to the parabolic, or fish-bellied rail, and has taken some pains to show the neutral axis, which has little or nothing to do with the best form of rail; yet he has forgotten to point out one of the most essential advantages which the parallel rail has over the parabolic rail, as I have frequently proved by the steelyard-lever. I have found that by holding the ends of the rails firmly down, at the joint-pedestal especially, the parallel rail of fifty pounds per yard will carry upwards of a ton more, with the same deflection, than the ends will do if they are allowed to rise, which they will of course do, if the end-pedestals are merely nailed down in the bad and ineffectual manner hitherto usual, namely, by common nails or spikes. When the rails are kept firmly down by proper means, the intermediate pedestals become so many fulcrums, and the tension of the fibres of the upper parts of the rail is called into play; as will be readily understood from inspection of the following diagram, in which A A represents the points of tension, and B B the points of deflection.



I perceive further from Mr. Barlow's experiments, that he considers that the best rail for strength ought to be from $4\frac{1}{4}$ to $4\frac{1}{2}$ inches deep, from the upper to the lower surface. I am quite confident, however, that it will be found that the best form of wrought iron rail ought not to exceed $3\frac{3}{4}$ inches deep, or 4 inches at most; for by making the rail higher, not only will the pedestal be much weakened, but there will be no possibility of holding the pedestals firm on their base, by cotter bolts or any thing else, more particularly at the shunts and curvatures of the line of railway, and even the stone blocks will be continually shaken. It is well known in practice, that the lower any rail and pedestal can be kept, the less is the destruction in them, and the less the action on the foundation upon which the stone blocks are placed. It is also equally well known, that a sufficient wrought iron rail can be made of the depth I have stated, (namely, $3\frac{3}{4}$ or 4 inches), to resist the action of a locomotive of 12 to 14 tons weight, at a speed of 40 or 50 miles per hour, (or even more if necessary,) if it is properly laid and adjusted.

I find that the different railway companies are now going to have their rails manufactured to weigh as much as 60lbs. per single yard. The additional 10lbs. per yard, ought, in my humble judgment, to be employed partly to strengthen the lower edge and make it rest more firmly on its basis, and partly to increase the width of the upper surface; both in the manner shown in fig. 6, which is a sectional view of what I consider the best form of a rail of this weight. My object in these modifications, is to increase the adhesion of the locomotive-engines, as well as to give a little more bearing on the peripheries of their wheels, in order to make them last longer.

I understand the Directors of the Birmingham and Liverpool Railway (the Grand Junction), have recently given an order for one or two thousand tons of parallel rails, the upper and lower edges of which are both alike. Now, the fact is, that twelve months ago, I gave one of their engineers a set of drawings, of rails and pedestals, of a variety of forms, *and this was one of them.* And in my letter to the Directors of the London and Bir-

mingham Railway, before quoted from, I also expressly made mention of this form of rail, as one that *might* be employed; but pointed out, at the same time certain objections to its use, which restrained me from proposing it for adoption. My words were these:—

"I have hesitated with myself, whether or not to make a pattern with the upper and lower edges exactly alike, so as to be able to use either side, in case the former should prove a little unsound in any part, which has hitherto been frequently the case, especially at the ends, as I am fully aware that the more metallic material that can be brought to the lower side, adds considerable strength to the rails; but as you seem disposed not to exceed 50lbs. per single yard, a little would be lost in the depth and height of the rail. Allow me to assure you, that no public railway company will ever regret having sufficient strength in the rails at the beginning, and that they ought not, by any means, to confine themselves to a pound or two in the yard, in order to make the work as complete and substantial as possible at the commencement. But, as it is, after mature consideration, and taking every thing into question, I prefer the models I have furnished (Nos. 8 and 9), as the keys will be more effectual."

Fig. 8, is a section of the form of rail that I recommended, and would still recommend, for adoption where it is desired to construct it, so that it may be inverted if necessary. It is what I call a "fancy rail," but ought to weigh at least 55 lbs. per yard.

Fig. 8.

Fig. 9.

Where a railway is intended for locomotive engines of only from eight to ten tons weight, a rail of the form represented in fig. 9, and weighing only 45 lbs. per yard, will be found to answer sufficiently well.

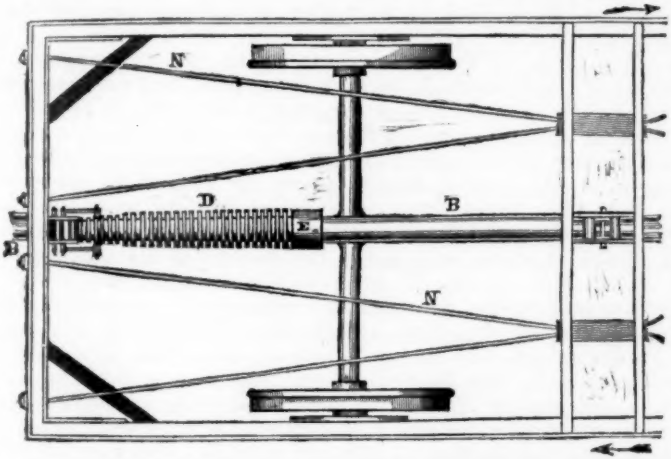
For America, where they have great difficulty in obtaining stone blocks, and are in the custom of fixing their rails on wooden sleepers of lengths varying from 30 to 50 feet, secured by cross sleepers, the best form of rail is that shown in fig. 7. I have been informed by American engineers that they can get plenty of a hard durable timber, very suitable for the purpose, for little more than the expense of cutting it down in the forests, and sending it to the saw mills to be cut into scantlings fit for immediate use; and that a railway bed of this description will last for nearly twenty years. Sometimes they lay their rails on cross sleepers only, dispensing with the side pieces. Several orders for rails of the form above referred to, are now executing under my inspection for railway companies in America.

Lond Mech. Mag.

Bergin's Patent Railway Buffing Apparatus. Immediately after commencing the traffic on the Liverpool and Manchester Railway (the first on which long trains of carriages were moved by locomotive engines at high velocities), it was found that every time a train was put in motion or stopped, violent concussions took place between the several carriages, equally disagreeable to the passengers and destructive to the carriages themselves. These concussions arose from the following cause: viz. by reason of the inertia of all heavy bodies, the same engine power which would be adequate to draw a given load along a railway at any required speed, would not be sufficient to start the same load from a state of rest; it was therefore necessary to connect the several carriages by chains of some considerable length, say three or four feet, by which arrangement the

inertia of the train was, as it were, divided into as many parts as there were carriages, and these several parts being each within the power of the engine, were overcome in succession; but as the first carriage would have attained a certain amount of velocity when the connecting chain came to pull the second, this second must of course be at once dragged from rest into motion at a speed nearly equal to that already acquired by the first, and so on through the entire train. Now a very slight knowledge of the principles of mechanics teaches that the concussions already mentioned were the necessary result of the action described; the same principle (inertia) produced the same effects at stopping a train, and also at every change in the relative velocities of the individual carriages when in motion; and as the force of these shocks was dependent on the velocities, the greater the speed of traveling the more violent they became.

The obvious remedy for the evil complained of was to provide a means by which the full amount of motion acquired by any part of the train should be gradually, not instantaneously, communicated to the other parts; the elasticity of a spring was a suitable means, and an apparatus was accordingly added to the Liverpool and Manchester passenger coaches, a sketch of which is annexed, and which has been termed a buffing-apparatus.



This apparatus is complex and consequently expensive; it also requires to be very strong, as on a little consideration it will be evident that the spring-bars, levers, and frame of the first carriage have to bear the resistance of the entire train; a very rigid spring is therefore necessary, the range of action of which is, of course, very limited, (in practice not exceeding a few inches,) consequently the concussions, although much diminished, are still very considerable. The apparatus being attached to the carriage-frame, which is, of course, supported on bearing springs, it rises and falls according to the load; whence it constantly occurs, from the carriages being unequally weighted, that the buffer-heads, opposed to each other, and which by right should be at the same level, vary by nearly their own diameter. Whence, in the event of a violent blow, the bars to which they are fastened are almost certain either to be bent so as not to play in their sockets, whereby the whole apparatus becomes inoperative; or else to be broken off,

(such we have found to be the case in every instance when an unusually severe blow took place). After the apparatus described was added to the Liverpool and Manchester carriages, it was found that the train no longer proceeded in a steady motion in the direction of the rails, but that each carriage had acquired a very considerable lateral motion, by which the flanges of the wheels were constantly striking or rubbing against the rails, so as to cause a considerable increased resistance from side friction; indeed, on looking along a train of six or eight carriages, the serpentine motion is very striking. The cause of this unsteady motion will be evident, when we recollect that the point from which each carriage is drawn is in one direction, the centre, and in the other the after extremity. These considerations, the result of numerous careful examinations of the carriages on the Liverpool and Manchester Railway previous to ordering our own, led me to seek for a remedy; as on the Dublin and Kingstown Railway, so very large a proportion of the traffic of which would be passengers, the extent of which it would be difficult to anticipate, but which must of necessity be immense, it became a matter of paramount importance to attain, as far as practicable, the most perfect comfort and security, and also to reduce as much as possible the wear and tear of the numerous carriages which the company must provide. The apparatus which I designed, and which has been successfully applied to thirty-five of our carriages may be thus described.

A slight frame of sheet-iron, consisting of two similar plates, three inches apart, each about $\frac{3}{16}$ thick, secured together by rivets, rests on turned bearings on the centres of the axles; a single bar B (I have used a welded iron tube of $\frac{5}{16}$ inches thick and three inches diameter, as being the stiffest), the entire length of the carriage, and extending about two feet beyond each end, passing through an oblong hole about three inches wide and nine inches long, is supported on this frame by rollers, allowing it to be moved lengthwise with great facility; on this tube or bar B is placed at either end (within the framing of the carriage) about four feet of spiral springs, D, of graduated strengths; one end of each of these sets of springs rests against a strong collar or boss, E, fixed to the bar or tube, and the other end against a small box of iron, attached to the frame and furnished with one of the rollers previously mentioned, also with two friction rollers projecting a little beyond its surface, and resting against the inner side of the carriage-frame end. To each extremity of the tube B B is attached a buffer head, by means of a bar of iron, passing through B B, and furnished with a nut and screw at each end; immediately within the buffer head, and resting against it, is a bar of iron, for attaching the carriages together. It will be observed, that this apparatus, lying loosely on the axles, is perfectly independent of the frame work of the carriage, which is supported in the usual manner on bearing springs, and, in consequence of the oblong holes rises or falls according to the load, without affecting the buffing-apparatus. The action of the apparatus is as follows:—The train being to be moved in the direction of the upper arrow, the motive power is applied and draws orward the central tube B B, thereby compressing the springs D between the boss E and the friction roller-box which rests against the end of the carriage-frame, without moving this latter until the elastic force of the compressed springs becomes sufficient to overcome the resistance presented by the friction and inertia of the carriage, when the latter begins to move forward so gently as not to be perceptible to persons seated there-

in; the second and each succeeding carriage in the train is by similar means brought from a state of rest into motion, as (altogether independent of the springs D) the tube B B acts merely as a simple connecting chain, rope, or bar, would. In case of a concussion from behind, or of one carriage running against another, it will be at once seen that the resistance is offered by the furthest end, the effect being to drive the tube B B forward, compressing the springs at the remote end; and the carriage will not be affected by the blow until (as in drawing the train) the elasticity communicated to the springs overpowers the inertia of the carriage, which then begins to move, actuated by a force just sufficient to start it; any ordinary velocity might be thus, theoretically, resisted by sufficient length of spring, without any strain or violence to the carriage receiving the blow; but, practically, the springs are limited to about four feet, allowing a range of action of about two feet, beginning to be compressed by a force equal to about twenty pounds, and presenting a gross resistance to entire compression of upwards of two tons, and which have been found sufficient for all practical purposes. It will be observed, that as the springs of each carriage act totally independent of each other, and of all the carriages in the train, except that to which they are attached, each has but to bear its own share of the resistance, the sum of which is made up of the separate resistances of all the springs acted on: thus, if one set offers a resistance equal to two tons receding through two feet, and that there be ten carriages in the train, the gross resistance to a concussion would be equal to twenty tons through two feet; and if the buffer-heads of each carriage were in contact, this great amount of resistance would be opposed without the carriages being necessarily moved forward as in the case of any obstruction on the rails, or any of them bearing more than two tons. On the contrary, in the other apparatus, supposing each spring also to resist a force of two tons, and to recede, as is the case in practice, about eight inches, each spring being acted on by all that preceded it, the resistance offered by a train of ten carriages would be but equal to two tons through ten times the space each separate spring moved, or $10 \times 8 = 80$ inches, or six feet eight inches; consequently the first and each succeeding carriage would, to enable all the springs to act, be forced through a space equal to the sum of the spaces through which the separate springs act; thus the first carriage of the ten would be forced through eight inches for each of the remaining nine carriages, or in all six feet, and it is easy to conceive the difference of the effect in the two cases. Experiments have been tried on this railway, by placing a single carriage, fitted with the new apparatus, on the rails, and running an engine and tender against it with a velocity of six to seven miles an hour, without producing any injurious effect. I have more than once sat in a carriage so struck, without sustaining any injury, or other effect, greater than is felt on starting a train of carriages fitted with the old apparatus.

Another effect which has been realised by the adoption of this apparatus, is a perfectly steady forward motion in the trains, whereby very much of the side friction of the flanges of the wheels against the rails is avoided; and instead of that undulating, lateral motion previously described, all the carriages constituting the train move forward in a steady path, as if they had not the power of motion independent of each other. Carriages are hereby rendered much less liable to go off the rails, and can be pushed before the engine in case of necessity with far greater confidence and less liability to accident; as although the impulse is given to the central bar from

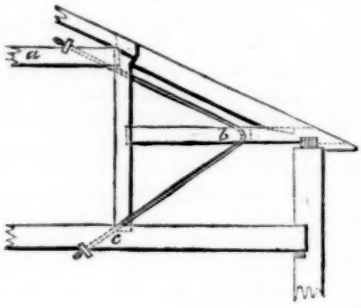
behind, yet it is obvious the carriage is acted upon from the front, precisely as it would be if drawn in the same direction. I have frequently, during our experimental trials before opening the railway, propelled one and two carriages in this manner at a velocity of thirty miles per hour with perfect safety. The diminution of side friction necessarily diminishes the power requisite to draw a train: the amount of saving in this respect I have as yet been unable to ascertain experimentally with sufficient accuracy to state in this place; I have, however, ascertained that it is very considerable.

One other object, of no trifling importance to a concern like the Dublin and Kingstown Railway, which must have an exceedingly large stock of carriages, is also effected; namely, a diminution of first cost of between 50*l.* and 60*l.* per carriage.

In describing the figures, I omitted to state that as the entire resistance to the action of the springs D is on the ends of the carriage-frame, the centre of each is armed with a strong plate of iron, about fifteen inches square, through which pass the tension rods N N to the outer angles of the opposite ends of the frame; consequently these rods receive the entire force of the springs. Lond. Mech. Mag.

Description of a new method of forming a Tie to a roof, where a direct Tie from Wall Plate to Wall Plate cannot be introduced. By W. Coles, Esq., Architect. Fig. 214, is a plan which I have found answer well as a tie to a roof, where a direct tie from plate to plate could not be introduced; and, as far as I know, it is original. I introduced it in this neighborhood in the roof of a cottage, in a case where the walls, having been carried up about four feet above the floor of the attic story, a direct tie across the building would have prevented the communication from one room to he other.

Fig. 214.



In the figure, a truss on the suspension principle is formed by a bar of iron (about three-quarters of an inch in diameter), which passes over the collar of the straining beam *a*, through a mortise in the tie *b*, and down through the floor-joist at *c*, and is tightened with a nut and screw at each end.

Kingsgate Street, Winchester, April, 1835. Lond. Architec. Mag.

Mechanics' Register.

Halley's Comet. The comet of 1835, when it came in 1456, was encountered by the anathemas of the whole Catholic Church, headed by the Pope. Dismayed at once by the progress of the Turks and the progress of the comet, Calixtus included them both in the same prayer of conjuration ordered to be said in all the churches.

It came again in 1531, and found America discovered, printing invented and in general use, and the reformation begun.*

1607 again completed its cycle. And now the *Copernican* system had been published to the world;† the *telescope* had been discovered; Galileo and Kepler had been born, and had probably laid the foundations of their discoveries, the one in mechanics, and the other in astronomy.

Next came 1682 and the comet, and the laws of motion were ascertained and published to the world; the discoveries of Kepler were made, and Newton had built up upon them the theory of universal gravitation.

1759 was to be the next period of its appearance, and its coming was now, for the first time, *foreseen*. Halley, afterwards Savilian Professor at Oxford, having undertaken to calculate the orbits of different comets which had, up to that time, been observed, presented, in 1705, to the Royal Society, a work called *Cometographia*, in which he predicted‡ the return of the comet of 1682 in 1758, an announcement received in those days with no little surprise and interest. It was, however, immediately foreseen by astronomers, that the path of this comet would be disturbed by the attraction of the planet Jupiter. Lalande and Clairaut undertook to calculate the amount of this disturbance. The work was one of enormous labour, which they would never have undertaken, as Lalande himself admits, had not assistance been rendered to them (strange to say) by a lady. To Madame Lepaute, the wife of a celebrated watch-maker in Paris, was assigned a principal portion of their calculations, and to that lady is due a principal share in their success. "During six months we calculated from morning till night, even during meals," says Lalande. They determined the actual perturbations, during 150 years, of Jupiter and Saturn, and they arrived finally, at the conclusion, that its coming would be delayed no less than 518 days by the attraction of Jupiter, and 100 more days by Saturn. The time of its perihelion passage§ was thus brought to 13th April, 1759: it was, nevertheless, stated that errors might have been made amounting to a month either way.

These conclusions Clairaut published to the world in November, 1758, when astronomers had already begun to look for the comet. It was first seen by a farmer of the name of Palitzch, near Dresden, on December 25, 1758, and at Paris, on January 21, 1759. It passed its perihelion on March 13, 1759, just one month after the time predicted.

The comet of 1759 was next to complete its orbit in 1835; and of its appearance in that year an account will shortly be given, when we shall first have answered two questions, which will, no doubt, have suggested themselves to every one who has read so far of this paper. They are these:

The comet of 1835 was, in its last revolution, influenced appreciably by the attractions of the four planets, Jupiter, Saturn, Uranus, and the Earth, and of course by the attraction of the Sun; and MM. Damoiseau and Pontécoulant, severally and independently, undertook the task of calculating their amount, and, separately, completed it. M. Pontécoulant found that the action of Jupiter would, as compared with the last revolution of

* This time is was accurately observed by one Apian, a Professor of mathematics, at Inglestadt.

† The great work of Copernicus, *De Revolutionibus*, was published in 1543.

‡ His words, translated, are, "Hence I dare venture to foretel that it will return again in 1758."

§ This term will be explained in the course of this paper.

the comet, on the whole accelerate it 135.34 days; that of Saturn, retard it 51.53 days; that of Uranus, retard it 6.07 days; and that of the Earth, 11.7 days. The principle portion of the influence of the Earth on its motions, dating as far back as the year 1759, or the very beginning of its revolution, at which time it passed very near the Earth.

Allowance being made for these, the whole period of the comet's last revolution was brought to 27937 days, and counting from the 13th of March, 1759, when it last passed through its perihelion, or nearest extremity of its orbit to the sun, this brought its next perihelion passage to the 13th of November, 1835.* At the same time M. Pontécoulant expressly stated, that there might be an error of a few days in this time, and assigned as a proximate cause of such an error, a possible incorrectness in the assumed masses of some of the planets. His words are, "we must here once more repeat, that it is not pretended that the time announced for the comet's return to its perihelion may not be in error some days." Elsewhere he says, "Thus then it is *conclusive that about the middle of November*, 1835, the passage of the comet through its perihelion will take place."

We next compare the results with the predictions. It had been announced that the comet would probably be visible during the first days of August. *It was seen on the 5th of August, at Rome,† by MM. Dumouchel and Vico*, its light being then exceedingly feeble. But more than this, the *precise place* in the heavens which the comet would occupy on every day whilst it should be visible, had been calculated and announced beforehand, *and it was when they directed their telescope to that point in the heavens which had been so predicted for the 5th of August, that MM. Dumouchel and Vico saw it.* It had been foretold that it would pass its perihelion on the 13th of November, that there might be an error of a few days, but that, nevertheless, it certainly would pass it about the middle of November. *It passed its perihelion on the 16th of November.*

It had been assigned by M. Pontécoulant, as a reason for the uncertainty which he thus felt in respect to the time of the perihelion passage, amounting, however, only to a few days, that the masses usually assigned to some of the planets by astronomers, and used by him in his calculations, might require correction. Of all the planets, Jupiter exercised the greatest influence over the motions of this comet. Any error in the mass which had been assigned to Jupiter, would, therefore, most affect the result. Now the mass he had assigned to Jupiter, was such, that 1054 such masses would equal the mass of the sun. Recent observations have shown, that the mass of Jupiter repeated only 1049 times, would equal the mass of the sun; and it has been ascertained, that *if M. Pontécoulant had used in his calculation this corrected measurement of the mass of Jupiter, instead of that which he did use, it would have protracted the predicted time of the perihelion passage three days, and brought it to the 16th, and to within six hours of the time when it actually took place,—an error of six hours in a period of seventy-six years!* Lond. Mag. Pop. Sc.

Gas Lighting. On Feb. 28, at the Royal Institution, after a brief sketch of the origin and progress of gas-illumination in London and its environs, Mr. Brande proceeded to details connected with the present state of the manufacture, illustrating the various sources of its extension and improvement. He began by adverting to the curious and complicated pro-

* M. Damoiseau fixed its perihelion passage to the 4th of November.

† The reader need not be reminded how pure and clear is the atmosphere of Rome.

ducts resulting from the destructive distillation of pit-coal; the principal elements of which he stated to be carbon, hydrogen, oxygen, and nitrogen, in conjunction with sulphur and iron derived chiefly from pyrites; these substances, by their mutual action during the application of a heat gradually raised to redness, yield olefiant gas, carburetted hydrogen, hydrocarbonous vapours, naphtha, naphthalin, tar, carbonic acid and oxide, cyanogen, hydrocyanic and sulphocyanic acids, sulphuretted hydrogen, ammonia, and several of its salts, water, and certain other products, of which a copious table was shown, containing also a statement of the relative proportions of gas, condensible products, and coke, afforded by three varieties of coal. Models and drawings of gas apparatus were then described, especially as illustrating the different modes of setting the retorts; and the progress of the gas from them was traced through the hydraulic main, where the tar, water, and ammoniacal liquor, are chiefly deposited to the condensers, purifiers, and gasometers. Some observations were then made in reference to the uses and properties of the various products, in the following order:—

1. *Ammoniacal Liquor.* This was shown to be a complicated solution of several ammoniacal and cyanic compounds in water. It is extensively used for the production of muriate of ammonia, which is obtained by saturating it with muriatic acid, evaporating, crystalizing, carefully drying the crystalized salt, and subliming it into large leaden receivers. A beautiful specimen of this salt, prepared by Mr. Leeson, of Greenwich, and weighing 2 cwt., was exhibited. Sulphate of ammonia is also prepared from the liquor; this, in its dry, crystalline state, is mixed with carbonate of lime, and affords carbonate of ammonia, of which a large mass, prepared by Mr. Leeson, was also shown. The presence of sulphocyanic and hydrocyanic acid in the ammoniacal liquor was shown by saturating it with muriatic acid, and adding persulphate of iron: the detection of these compounds and their application to the manufacture of Prussian blue, Mr. Brande said was owing to the skill and ingenuity of Mr. Lowe. This product, therefore, of the gas manufacture, once considered as useless, yields a variety of useful and important compounds, and has opened a new field of chemical art.

2. *Tar.*—This product is useful as a coarse paint, and for the purpose of paying and caulking vessels: it is also more importantly applicable as fuel in the gas-works, where, mixed with water, it is suffered to dribble into the fire; three gallons of this mixture per hour being sufficient to heat five retorts. When distilled, it yields naphtha, a highly volatile and inflammable liquid, which is occasionally burned in lamps, or used as a solvent in the manufacture of certain varnishes.

3. *Lime Liquor.*—This is the mixture of lime and water, through which the gas has been passed, chiefly with a view of freeing it from carbonic acid and sulphuretted hydrogen: it is from time to time drawn from the purifiers and suffered to subside. The deposit, or thick portion, is made again into lime, or is used for luting the retort-lids; the clear portion is pumped into shallow vessels placed in the ash-pits of the retort-furnaces, where it evaporates, and tends to preserve the bars, probably by keeping them cool. Another use, however, is now made of it, as follows:—Acid persulphate of iron (copperas liquor) is added to it, which throws down a green precipitate, that may itself be used as a paint, but which, digested in a solution of potash, yields a ferrocyanate of potash, sufficiently pure to throw down Prussian blue from common copperas liquor.

4. *Gas.*—The specific gravity of the purified gas, and, consequently, its

composition, vary considerably at different periods of the distillation; its average specific gravity, as taken from the gasometers, is 0.410; each cubic foot weighing 240 grains. After some remarks upon the manufacture of gas generally, and upon the various forms of carbon, and other products occasionally found in the retorts, Mr. Brande made some observations upon the sources of the luminosity of different gases, and on photometers; and then proceeded to details connected with the process as carried on upon the large scale by the different companies; stating that his experience was chiefly derived from the Chartered Gas Company, the officers of which had most assiduously assisted him in all inquiries connected with the subject generally, and with the particular object of the present inquiry; Mr. Lowe, and Mr. Frederick Winsor, had kindly given him access to their information; and Mr. Crossley had supplied models of gas-meters and their appendages, with much of the other apparatus upon the table. Mr. Brande estimated the number of retorts worked by the above-mentioned company at 750; and assuming them to be about one-fourth of the number employed in London, the whole amount will be 3,000 retorts, of about 15 cwt. each; so that the cast iron thus employed, to say nothing of the enormous amount in pipes and other apparatus, amounts to 2,240 tons. The total stowage for gas in the gasometers of the chartered company, Mr. Brande estimated at 820,000 cubic feet; or, for London, 3,280,000 cubic feet. He said, that the number of burners supplied by this company amounted to about 42,000; or, for the whole of London, to 168,000; and, estimating the consumption of each burner at five cubic feet per hour, the average *hourly* consumption of gas would amount to 840,000 cubic feet; and taking five hours per day as the average time of burning, we have 4,200,000 cubic feet of gas as the daily average consumption. Mr. Brande concluded by explaining the different checks resorted to by the companies in reference to the quantity of gas produced and consumed; and by a description of the gas-meters, pressure-gauges, tell-tales, and governors, all illustrated by a series of excellent models and apparatus. The following tables were exhibited, as furnishing data and details connected with several of the points referred to in this lecture, together with some others which we have not room for, showing the relative weights and volumes of gas, and of the consumption of atmospheric air in its combustion:—

For the total annual supply of gas to the metropolis, there are required 200,000 chaldrons of coal, yielding 2,400,000,000 cubic feet of gas; the gas weighing 75,000,000 lbs. The light thus produced is equal to 160,000,000 lbs. of mould candles, of six to the pound; the bulk of the coal is equal to 10,800,000 cubic feet, or 400,000 cubic yards; or to a cube of 222 feet in the side, or of 74 yards. Arcana of Science, 1835.

List of American Patents which issued in June, 1836.

(CONTINUED FROM PAGE 215.)

453. *Dry dock.*—J. Houston, A. Kinman, & J. Ingraham, Buffalo, N. Y. 22
454. *Horse collars, forming.*—G. Warner and R. Robinson, Canajoharie, N. Y. 22
455. *Raising water.*—Jesse C. Wood, Euphrata, N. Y. 22
456. *Fence pickets, cutting.*—J. Tichnor, S. Goodrick, & G. A. Hart, Ithaca,. Y. 22
457. *Straw, corn, &c. cutting.*—E. Tarbox and C. F. Kneeland, Ogden, N. Y. 22
458. *Wheel plough.*—J. C. Ferguson, Hydesville, Missouri, 22
459. *Wagon tilts.*—Stephen Beebe, Norwich, Conn. 22
460. *Cotton, spinning.*—William P. Brayton, N. Y. 25
461. *Chocolate, grinding.*—G. W. Wait, Baltimore, 25
462. *Chocolate, moulding.*—G. W. Wait, Baltimore, 25
463. *Chocolate ingredients, heating.*—George W. Wait, Baltimore, 25
464. *Churn.*—Samuel Tyler, New Gloucester, Maine, 25
465. *Planing machine.*—P. M. Martz, Marion county, Ind. 25
466. *Oven, reflecting.*—Benj. Ames, Ithaca, N. Y. 25
467. *Hair and oakum, picking.*—Robert B. Lewis, Hallowell, Maine, 25
468. *Cooking stove.*—Gould Thorp, N. Y. 25
469. *Water heating machine.*—D. B. Barnum, N. Fairfield, Conn. 25
470. *Distilling.*—Peter Swartz, Jr. Muncey, Penn. 25
471. *Cooking stove.*—Thomas Shaw, North Yarmouth, Maine, 25
472. *Flyers for cotton spinning.*—Jason Morse, Newtown, Mass. 25
473. *Water wheels.*—Orson Waldo, Newark, Tioga county, N. Y. 25
474. *Palm leaf hats.*—Fred. Groening, Brooklyn, N. Y. 25
475. *Planing machine.*—Ira Gay, Dunstable, N. H. 25
476. *Thrashing machine.*—Peter Cleveland, Yancy mills, Va. 25
477. *Rotary steam engine.*—Shepherd Whitman, New Albany, Ind. 25
478. *Parlour grates.*—William Anderson, N. Y. 25
479. *Boot cramp.*—Hubbard L. Pierce, St. Johnsbury, Vt. 25
480. *Vegetable cutter.*—Henry Mellish, Walpole, N. H. 25
481. *Saddles.*—Benjamin Kraft, Reading, Penn. 28
482. *Compass, surveyors.*—Nathan Bassett, Wilmington, Del. 28
483. *Harvesting machine.*—H. Moore and J. Hascall, Kalamanzo, Mich. 28
484. *Cars, Rail Road attaching.*—L. Pickering and J. Lightner, Boston, Mass. 28
485. *Steam power.*—William Avery, Syracuse, N. Y. 28
486. *Power loom.*—Benjamin Lapham, Waterford, N. Y. 28
487. *Cooking stoves.*—Sebastian H. Laciar, Macungy, Penn. 28
488. *Buildings, constructing.*—Lewis Knapp, N. Y. 28
489. *Feathers, dressing.*—Benton P. Coston, Philadelphia, 28
490. *Drawing knife.*—Edmund Richards, Hingham, Mass. 28
491. *Chair, easy.*—Andrew Wood, Charlestown, Va. 28
492. *Spoons, casting.*—William Mix, Prospect, Conn. 28
493. *Cooking stove.*—P. F. Perry, Rockingham, Vermont, 28
494. *Plane, revolving.*—Samuel Hedge, Brattleboro' Vermont, 28
495. *Clover seed, hulling.*—J. Hopper and A. Douty, Moresborough, Penn. 30
496. *Pottery, moulding.*—J. C. Mendell and R. B. Ricketts, Maysville, Ky. 30
497. *Mowing machine.*—John Drummond, Waterford, N. Y. 30
498. *Leather, glazed.*—E. G. Adams, Decatur, Georgia, 30
499. *Horse power.*—John Abbott, South Reading, Mass. 30
500. *Bitt-stock.*—Jeremy Taylor, Hebron, Conn. 30
501. *Stoves.*—James Atwater, New Haven, Conn. 30
502. *Saw mill.*—Simon Willard, N. Y. 30
503. *Cultivator.*—J. S. Eastman, Baltimore, 30
504. *Parlour stove.*—Beriah Douglass, Albany, N. Y. 30
505. *Cooking stove.*—Beriah Douglass, Albany, N. Y. 30
506. *Pump.*—Abraham T. Mixsell, Oxford, N. J. 30
507. *Over shoes.*—Daniel H. Bond, Canterbury, Conn. 30
508. *Hides, unhairing.*—James Banks, Dexmont, Maine, 30
509. *Bee hive.*—John M. Weeks, Salisbury, Vermont, 30
510. *Sawing staves.*—Chas. M. Keller, Washington, D. C. 30
511. *Crane.*—Gilbert Sherwood, Erie, Penn. 30
512. *Raising vessels.*—Tobias Cook, Scituate, Mass. 30

CELESTIAL PHENOMENA, FOR NOVEMBER, 1836.

Calculated by S. C. Walker.

Day.	H'r.	Min.					
2	17	28	Im	ι Leonis	,6,	N. 39°	V.358°
2	18	49	Em			258	240
21	8	52	Im	53 Arietis	,6,	173	130
21	9	44	Em			255	224
23	14	3	N. App.	☽ and k Tauri	,6,	☽ North 3′.0	
26	16	52	Im	c Geminorum	,6,	13	64
26	17	35	Em			311	8
28	9	7	Im	Cancri	,6,	119	73
28	9	51	Em			225	176
29	12	1	Im	ν Leonis	,3.4,	77	24
29	13	1	Em			247	194

Meteorological Observations for July, 1836.

Moon. Days.	Thermometer. Sun rise.	2 P. M	Barometer. Sun rise.	2 P. M	Wind. Direction.	Force.	Water fallen in rain. Inches.	State of the weather, and Remarks.
☽ 1	64°	86°	Inches	Inches	W.	Moderate.		Hazy—clear.
2	67	83	29.85	29.85	SW.	do.		Fog—clear, sultry.
3	68	81	29.85	29.90	SW.	do.		Fog—lightly cloudy.
4	71	82	29.90	29.90	SW.	do.		Cloudy—flying clouds.
5	72	86	29.85	29.85	SW.	do.		Cloudy—clear.
6	70	82	29.86	29.86	SW.	do.		Lightly cloudy—clear.
7	70	83	29.90	29.93	W.	do.		Clear,
8	70	85	29.80	29.84	W.	do.		do.
9	70	80	29.80	29.7	SW.	do.		Clear—lightly cloudy.
10	74	78	29.80	29.80	N.	do.		Clear—floating clouds.
11	66	76	29.70	29.85	SW.	do.		Lightly cloudy.
12	62	76	29.90	29.90	N. E.	do.		Clear.
13	70	76	29.98	29.98	N. NE.	do.		do.
14	70	80	29.85	29.85	E.	do.		Cloudy—lightly cloudy.
15	60	71	29.80	29.86	E.	do.		Rain—Cloudy,
16	64	74	29.94	29.86	NE.	do.	1.00	Clear—flying clouds.
17	58	71	30.05	30.05	N.	Moderate.		Clear day.
18	58	72	30.00	30.00	N.	do.		Clear day.
19	64	80	30.10	30.10	W.	do.		Clear day.
20	64	84	29.95	29.86	NE.	Brisk.		Light cloudy—rain in night.
21	67	81	29.71	29.65	SW.	Moderate.	.02	Lightly cloudy,
22	69	84	29.54	29.54	S. E.	do.	1.05	Clear—flying clouds.
23	62	78	29.75	29.80	SE.	do.		Cloudy—flying clouds.
24	64	78	29.80	29.83	SW.	Brisk.	.50	Cloudy—rain in night.
25	68	79	29.83	29.90	NW.	Moderate.		Cloudy—flying clouds.
26	67	69	29.80	29.83	N.	do.	.60	Cloudy—rain.
27	62	73	29.90	29.95	SE.S.	do.		Clear day.
28	66	75	29.95	29.90	SE.S.	do.		Cloudy—lightly cloudy,
29	66	79	29.85	29.80	S.	Brisk.		Cloudy—lightly cloudy.
30	70	80	29.65	29.65	W.	Moderate,	.03	Drizzle—cloudy.
31	69	81	29.80	29.85	W.	do.		Clear day.
Mean	5:30	79.30	29.85	29.85			3.30	

Thermometer.

Maximum height during the month 88, on 7th.
Minimum do. . 58, on 17th & 18th.
Mean do. . 72.80

Barometer.

30.50 on 17th,
29.54 on 22nd,
29.86